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MODIS Information, Data, and Control System (MIDACS) Level II Functional Requirements

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1988

PREFACE

This document establishes the functional requirements for the MODIS Information, Data, and Control System (MIDACS). The purpose of the MIDACS Functional Requirements Document is to provide a basis for the mutual understanding between the users and the designers of the EosDIS, including the requirements, operating environment, external interfaces, and development plan. In defining the requirements and scope of the system, this document will describe how MIDACS will operate as an element of the EOS within the EosDIS environment. This version of the Level-II Requirements Document follows the earlier release of a preliminary draft version. The sections on functional and performance requirements do not yet fully represent the requirements of the data system needed to achieve the scientific objectives of the MODIS instruments and science team. Indeed, the team members have not yet been selected and the team has not yet been formed. However, it has been possible to identify many relevant requirements based on the present concept of EosDIS and through interviews and meetings with key members of the science community. These requirements have been grouped by functional component of the data system, and by function within each component. These requirements have been merged with the complete set of Level-I and Level-II context diagrams, data flow diagrams, and data dictionary.

The study team is indebted to: Wayne Esaias, Chris Justice, and Joel Susskind for detailed information regarding the science requirements; Bill Barnes, John Barker, and Bruce Guenther for information regarding MODIS instrument concepts; H. Lee Kyle, and Dick Stonesifer for their insight into aspects of data processing, instrument control, and data storage; and to Al Fleig for his assistance in applying the guidelines being set forth by EosDIS.

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1. GENERAL INFORMATION

1.1 SUMMARY

The Moderate Resolution Imaging Spectrometer (MODIS) is planned to fly on the NASA Polar-Orbiting Platform 1 (NPOP-1) as a part of the Earth Observing System (EOS) beginning in the mid-1990's. The MODIS Instrument is expected to be composed of two components: the MODIS-T, for a "tiltable" cross-track scanner, and the MODIS-N for a nadir viewing cross-track scanner. As currently envisioned, the instruments shall provide multi-year, continuous terrestrial coverage across a 1780-kilometer swath with 104 channels covering the visible, near-infrared, and thermal infrared spectral regions. The channels have been selected to provide land-science, oceanographic, and meterological observations at spatial resolutions ranging from one kilometer to 250 meters at nadir.

As a consequence of the design of MODIS, a high data rate and an extremely large data archive volume are anticipated. Furthermore, specific aspects of the EOS Data and Information System (EosDIS) combine to shape the processing requirements for the MODIS data system; in particular, the release of certified data products in accessible archives within 48 hours of real time.

1.1.1 Purpose

This document establishes the functional requirements for the MODIS Information, Data, and Control System (MIDACS). The purpose of the MIDACS Functional Requirements Document is to provide a basis for the mutual understanding between the users and the designers of the EosDIS, including the requirements, operating environment, external interfaces, and development plan. In defining the requirements and scope of the system, this document will describe how MIDACS will operate as an element of the EOS within the EosDIS environment.

1.1.2 Scope

The MIDACS fulfills the responsibilities of instrument monitoring and control, as well as data acquisition, management, production, certification, and distribution. In order to design the MODIS data system to efficiently and reliably fulfill each of these functions, the system's functional, performance, and other requirements must be clearly stated. It is recognized that the requirements of the MODIS data system will evolve as information is compiled, the science team formed, and the instrument design refined. This requirements document will evolve in response to evolutions in the scientific requirements. In this first draft, not all requirements are fully addressed: some specific requirements are identified, yet left undefined; these will be completed in later drafts.

1.1.3 Organization of the Document

The MIDACS Functional Requirements Document is organized into nine sections. Section 1 provides the reader with general information relating to the MODIS data system, including standards and applicable references. Section 2 provides an overview and functional description of the MODIS Data System. The system overview concentrates on major functional aspects of EosDIS as they relate to MODIS, while the functional description of the data system emphasizes the specific areas internal to MIDACS. Section 3 states the functional requirements of all aspects of the MIDACS, and emphasizes the Instrument Support Terminal (IST), the Instrument Control Center (ICC), the Central Data Handling Facility (CDHF), the Team Member Computing Facility (TMCF), and the Data Archive and Distribution System (DADS). Section 4 states the performance requirements. Section 5 addresses the interfaces between MIDACS and the outside world, termed external, which include specific aspects of the EosDIS

as well as other users Sections 6, 7, and 8, respectively, discuss the physical requirements, delivery and installation requirements, and design and implementation constraints of the MIDACS. The development plan for the MODIS Data System is documented in Section 9. Finally, Section 10 contains the appendices listing acronyms, the set of assumptions employed in developing this set of functional requirements, the MODIS Data System Dictionary, and data rate, volume, storage, and processing considerations.

1.1.4 Standards

The following standards will be followed during the MIDACS development cycle:

a. Software Engineering Standards
b. Operating System Standards
c. Common Operating System/Exceptions
d. Coding and Software Implementation Standards
e. Standard Media and Protocols
f. Programming Language Standards
g. Standard Formatted Data Unit
h. Other Standards

1.2 REFERENCES AND APPLICABLE DOCUMENTS

1. Earth Observing System Data and Information System Requirements, Level I, NASA/GSFC, March 15, 1988

2. Eos Control Center Requirements, Memo from Steve Tompkins, NASA/GSFC Code 511, October 28, 1987

3. EosDIS Baseline Report, Draft #2, CTA, May 26, 1988

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6. Earth Observing System Data and Information System Report of the EOS Data Panel, Volume IIa, NASA, 1986

7. An Operation Concept and Information System for the Earth Observing System CTA, January 1985

8. MODIS (Moderate-Resolution Imaging Spectrometer) Instrument Panel Report, NASA, Volume 11b, 1986

9. Phase A Study Report For the Moderate Resolution Imaging Spectrometer Data System, Level-1 Processing (Draft), SAR

10. EosDIS Control Center Concepts V2.1 February 25, 1988

11. EosDIS Interface Definition Document, (Draft) CTA, May 11, 1987

12. HIDACC Functional Requirements Document - Preliminary Version 1.0, JPL, December 21, 1987.

13. System Specifications for The Space Telescope (ST) Data Archive and Distribution Service (DADS), Computer Sciences Corp.

14. Moderate Resolution Imaging Spectrometer-Nadir (MODIS-N) Specification for a Phase-B Study. NASA Goddard, Nov. 10, 1987.

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16. MODIS: An Advanced Facility Instrument for Studies of the Earth as a System. V. Salomonson et al., 1988. Preprint for IEEE.

17. Eos Science and Mission Requirements Working Group Report, Vol. I Appendix (NASA/GSFC).

18. MIDACS Data Flow Report by the MODIS Data System Phase-B Study Team.

19. Quick-Look Data Requirements of the MODIS Instrument Team, the MODIS Data System Study Team, October 7, 1988.

20. MIDACS Preliminary Operational Concept, MODIS Study Team, September 1988.

2. OVERVIEW AND SYSTEM DESCRIPTION

This section addresses the environment and context within which the MIDACS will operate, and provides a general description of the MIDACS as a system and the EosDIS elements that MIDACS will interact with.

2.1 SYSTEM OVERVIEW

MODIS has been designated as a facility instrument on the first NASA polar orbiting platform, NPOP-1, scheduled for launch in 1995. It is the responsibility of NASA to provide a ground system by that time which will control the operation of the MODIS instrument on board the platform and perform the data acquisition, monitoring, processing, and distribution functions to serve the user community.

NASA's Goddard Space Flight Center (GSFC) is responsible for the design and development of the MODIS ground system. This ground system, called the MODIS Information, Data, and Control System (MIDACS), will be one of the elements operating in the context of the overall EosDIS. The EosDIS will be responsible for the end-to-end data flows involving the EOS Platform Data System, MODIS Instrument Data System on board the platform, the Tracking and Data Relay Satellite System (TDRSS) and its ground terminals at White Sands, the various EOS ground systems, and the users. Figure 1 describes the EosDIS environment under which the MIDACS will operate. The following sections provide a brief description for each of the systems in the EosDIS and MIDACS environments.

2.1.1 MODIS Instrument

The MODIS instrument will be on the EOS platform NPOP-1 that has a nominal altitude of 824 km, an inclination of 98.7° to maintain a Sun-synchronous orbit, and a period of approximately 101 minutes. The instrument is expected to cover 104 spectral bands in the range of 0.4 to 14.2 microns. MODIS will be divided into two sensors designated as MODIS-N (nadir) and

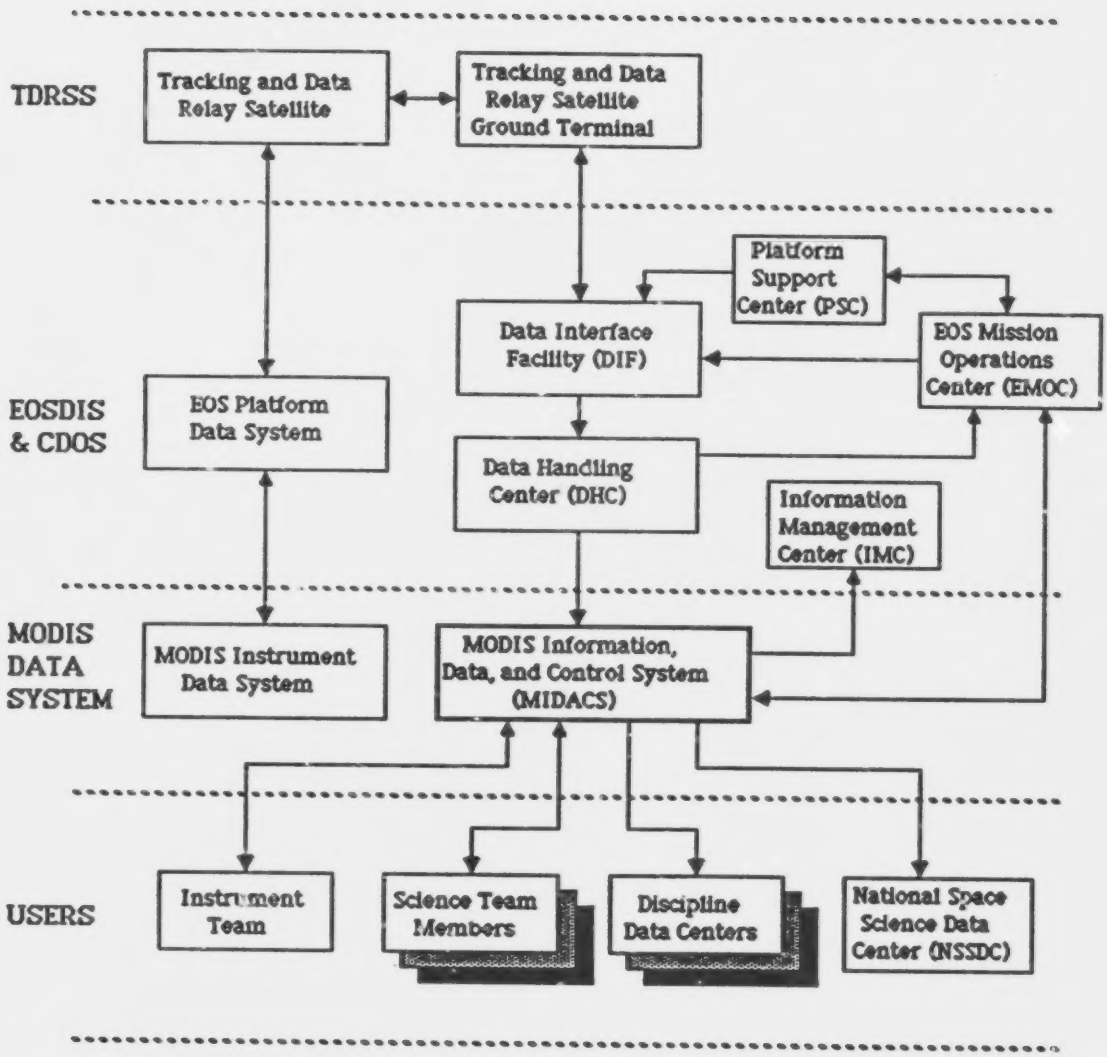


Figure 1. The MODIS Data System in the EosDIS Environment

MODIS-T (tilt) The instrument is expected to have a data rate of from 2 (night) to 17 (day) Mbps. The long-term average data rate is anticipated to be about 10 Mbps.

2.1.2 MODIS Instrument Data System

The MODIS Instrument Data System will be one of many instrument data systems on the NPOP-1, each of which would provide similar functions to support an instrument.

2.1.3 EOS Platform Data System

The Eos Platform Data System provides the common monitor and control of all instruments on the platform. In addition, it provides the common services (communication, power, etc.) for all instruments.

2.1.4 TDRSS Ground Terminal (TGT)

The TDRSS provides the uplink and downlink capability for the EOS platform. On the average, a platform should have access to the TDRSS for about one-third of its orbit.

2.1.5 Data Interface Facility (DIF)

The Data Interface Facility (DIF) provides data communication, data buffering, and data routing between the TDRSS ground terminal and the ground data network. It is the gateway between the space network and ground data network.

2.1.6 Data Handling Center (DHC)

The Data Handling Center (DHC) is responsible for Level-0 processing of low-rate data to remove any artifacts introduced into the data by the transport system. As data leaves this function it should look as it did when it left the instrument.

2.1.7 Eos Mission Operations Center (EMOC)

The Eos Mission Operation (EMOC) provides the coordination required to allocate resources for, and schedule and command the many instruments which fly on, the Eos platforms.

2.1.8 Platform Support Center (PSC)

The PSC is a proposed GSFC facility under the Customer Data and Operations System (CDOS) that will provide mission control support for a variety of space programs at GSFC. The PSC will perform standard control center functions to monitor and control the platform operations. The PSC will be involved in the planning and scheduling functions for EOS payloads, as well as in all aspects of planning, scheduling, commanding, and telemetry monitoring of the platform core.

2.1.9 Information Management Center (IMC)

The Information Management Center (IMC) is the central data management facility for the EosDIS. Its principle functions are to provide the users with a mechanism for placing orders for products and to accommodate the user with information as to where the particular data products are stored.

2.1.10 National Space Science Data Center (NSSDC)

The NSSDC will serve as a long-term permanent archiving and distribution center for data obtained on NASA Space and Earth Science flight investigations. The NSSDC will develop and perform a variety of services to enhance the scientific return in these missions. The data sets archived will contain high-level information. The NSSDC is not a part of EosDIS.

2.1.11 Discipline Data Center (DDC)

The various discipline data centers (DDCs) (i.e., NASA Ocean Data System (NDOS), NASA Land Data System (NLDS), and NASA Climate Data System (NCDS)) are responsible for providing research scientists with disciplinary areas. These DDCs, although not part of the EosDIS, will receive MODIS products from the MIDACS.

2.1.12 Users

The MIDACS will interface with both GSFC local and remote users. They are classified here as the instrument team leader and members and other various science teams. The MODIS products will support research scientists of the following disciplines: ocean, land, and atmosphere.

2.1.13 External Interfaces

Figure 2 provides a context diagram of the MIDACS and shows the interfaces with the external elements.

2.2 FUNCTIONAL DESCRIPTION OF MIDACS

Figure 3 depicts the internal systems within the MIDACS and their interfaces. The following sections are a list of internal centers of MIDACS and the respective functions which support the MODIS instrument.

2.2.1 Instrument Support Terminal (IST)

The IST is essentially a workstation connected to the ICC. It gives the team leader or members access to the engineering data or quick-look science subset of a payload in order to support instrument integrity functions and/or to initiate commands and plans for specialized conditions. The IST Context Diagram is provided in Figure 4.

2.2.2 Instrument Control Center (ICC)

This center is responsible for the ground control of the operation of the MODIS instrument on board the platform. The ICC will support the instrument planning, scheduling, commanding, and status monitoring of MODIS. The ICC Context Diagram is provided in Figure 5.

2.2.3 Team Member Computing Facility (TMCF)

A scientist team member will be responsible for the development and maintenance of the algorithms for the production of data sets. The TMCF will be distributed and will provide computing resources at research instrument team member locations to be used in the development and test of algorithms, the productions of data sets, and the assessment of data quality. The TMCF Context Diagram is provided in Figure 6.

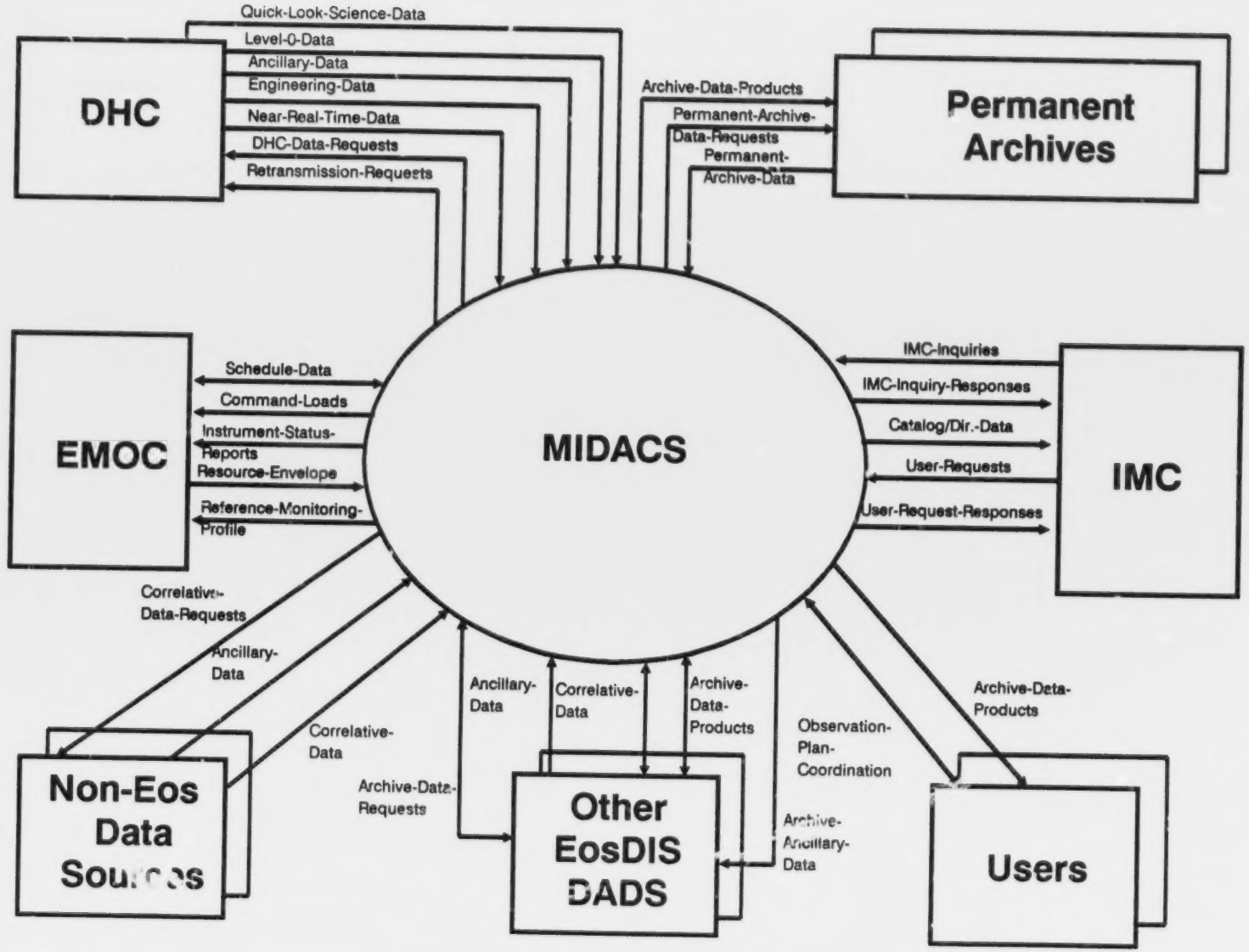


Figure 2. MIDACS Context Diagram

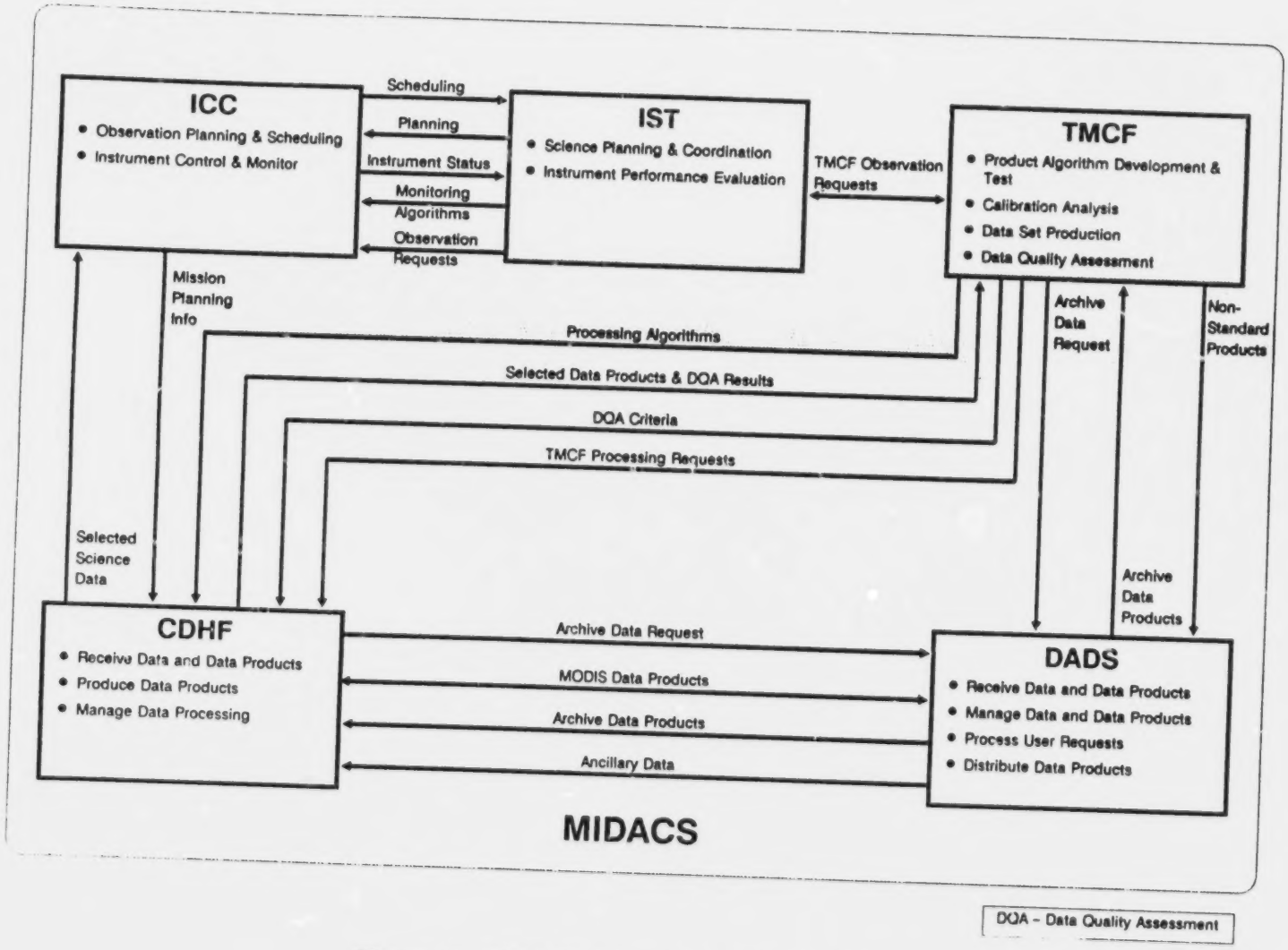


Figure 3. MIDACS Element Functional Allocation Diagram

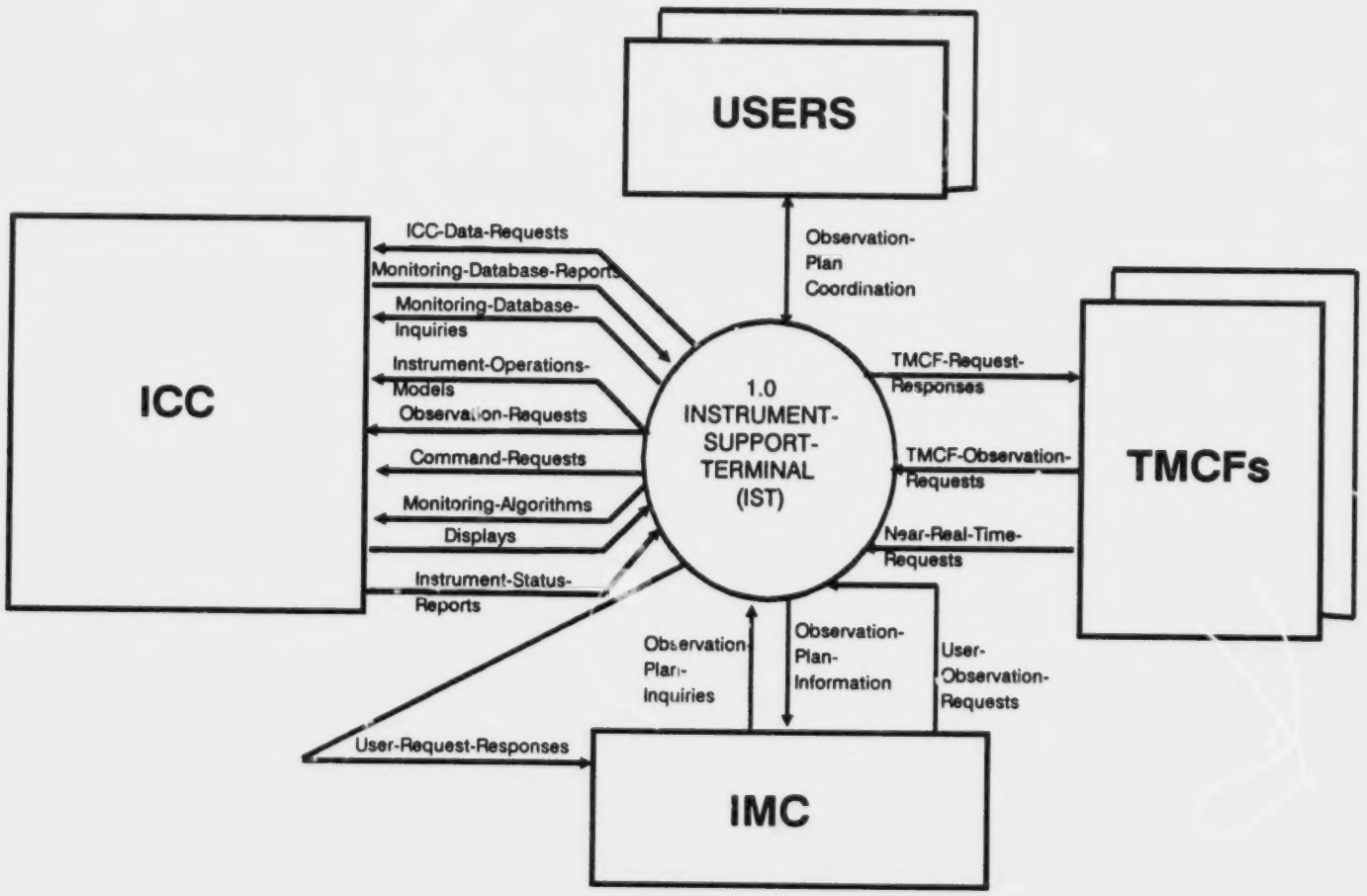


Figure 4. The IST Context Diagram

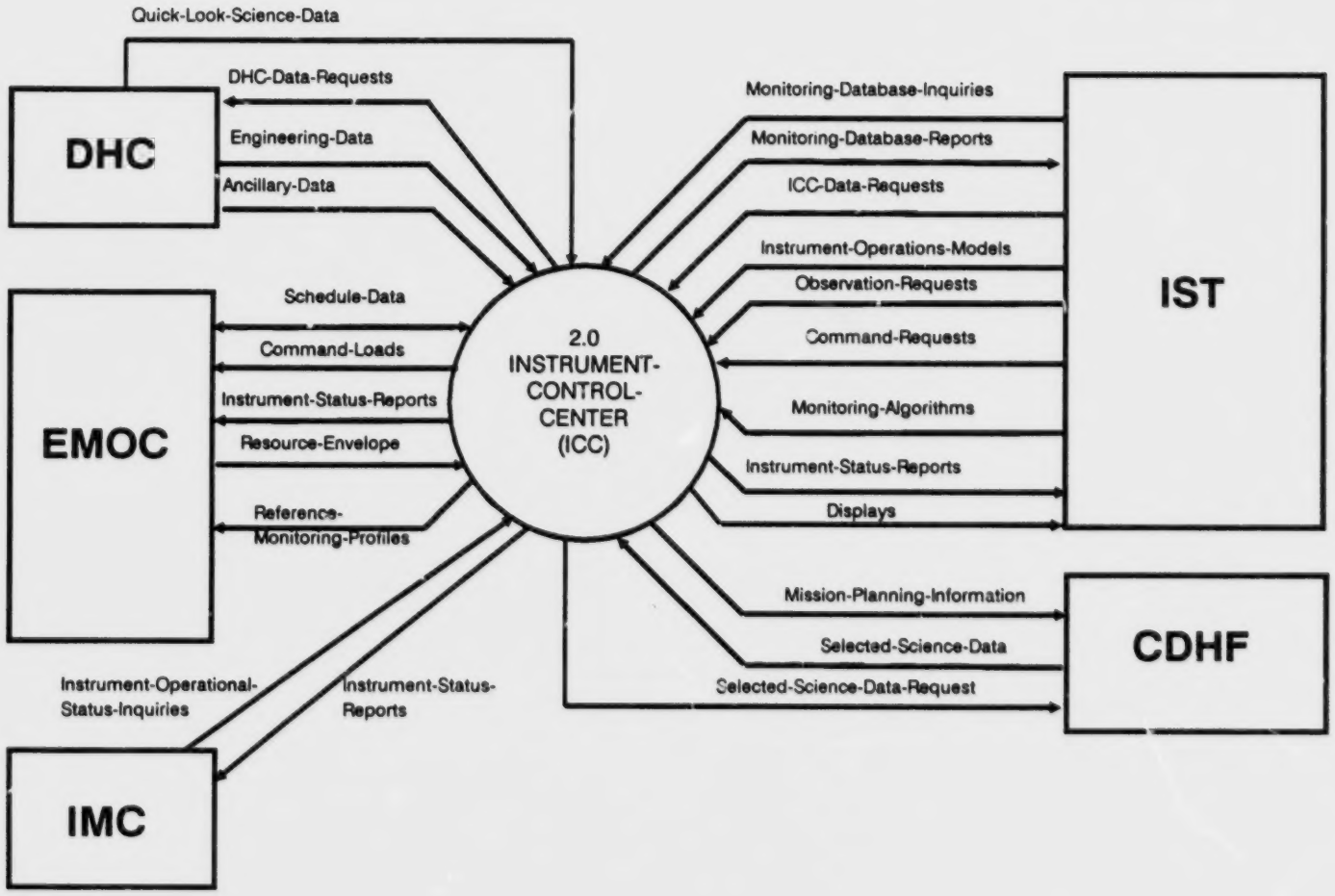


Figure 5. The ICC Context Diagram

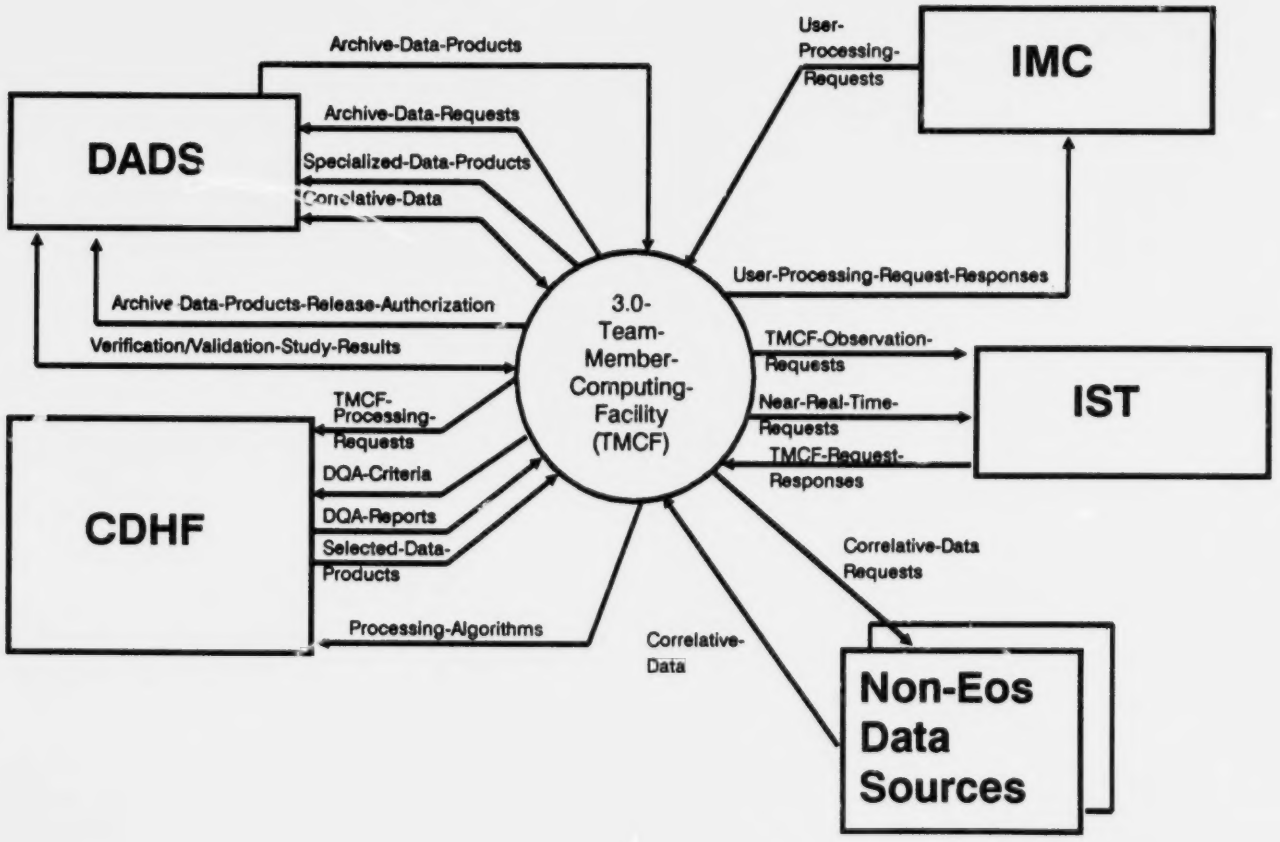


Figure 6. The TMCF Context Diagram

2.2.4 Central Data Handling Facility (CDHF)

The CDHF has the responsibility of receiving instrument data, and processing and generating useful products for the user at predetermined levels of processing. The levels of data to be produced include Level-1A (reversible to Level-0), Level-1B (calibrated and Earth-located radiances), Level-2 (geophysical parameters), Level-3 (gridded and averaged products), and Level-4 (comparisons to non-MODIS products). The CDHF Context Diagram is provided in Figure 7.

2.2.5 Data Archive and Distribution System (DADS)

The DADS will provide for the ingest and temporary storage and management of processed data sets, catalogs, and directories for data processed by the CDHF and others. It provides an interface to the users for distribution of requested products and archiving of data to a permanent archive. The DADS Context Diagram is provided in Figure 8.

3. FUNCTIONAL REQUIREMENTS

FNR1: The MODIS data system shall support atmospheric, oceanographic, and land science field experiments by providing near-real-time processing of MODIS data. **SOURCE:** Reference 19.

FNR2: A center will need to have the capability to trace the data flow back through the processing system to the instrument, aiding in the isolation and correction of problems. **SOURCE:** Reference 6, page 2.

FNR3: Careful consideration should be given to standard format structures for data interchange. **SOURCE:** Reference 6, page 14.

FNR4: Any standard adopted under the EOS infosystem auspices should take machine and data independence practices into account. **SOURCE:** Reference 6, page 13.

3.1 INSTRUMENT SUPPORT TERMINAL (IST)

[See Data Flow Diagram 1.0: IST Functional Data Flows]

FNR5: The IST shall provide the MODIS team leader with the capability to monitor MODIS from a home institution while maintaining access security. **SOURCE:** Reference 2 (IST Facility and Reference 3).

FNR6: The IST functions shall include procedure generation, anomaly investigation, operations monitoring, and possibly commanding (via requests to the ICC). **SOURCE:** Reference 2 (IST Facility).

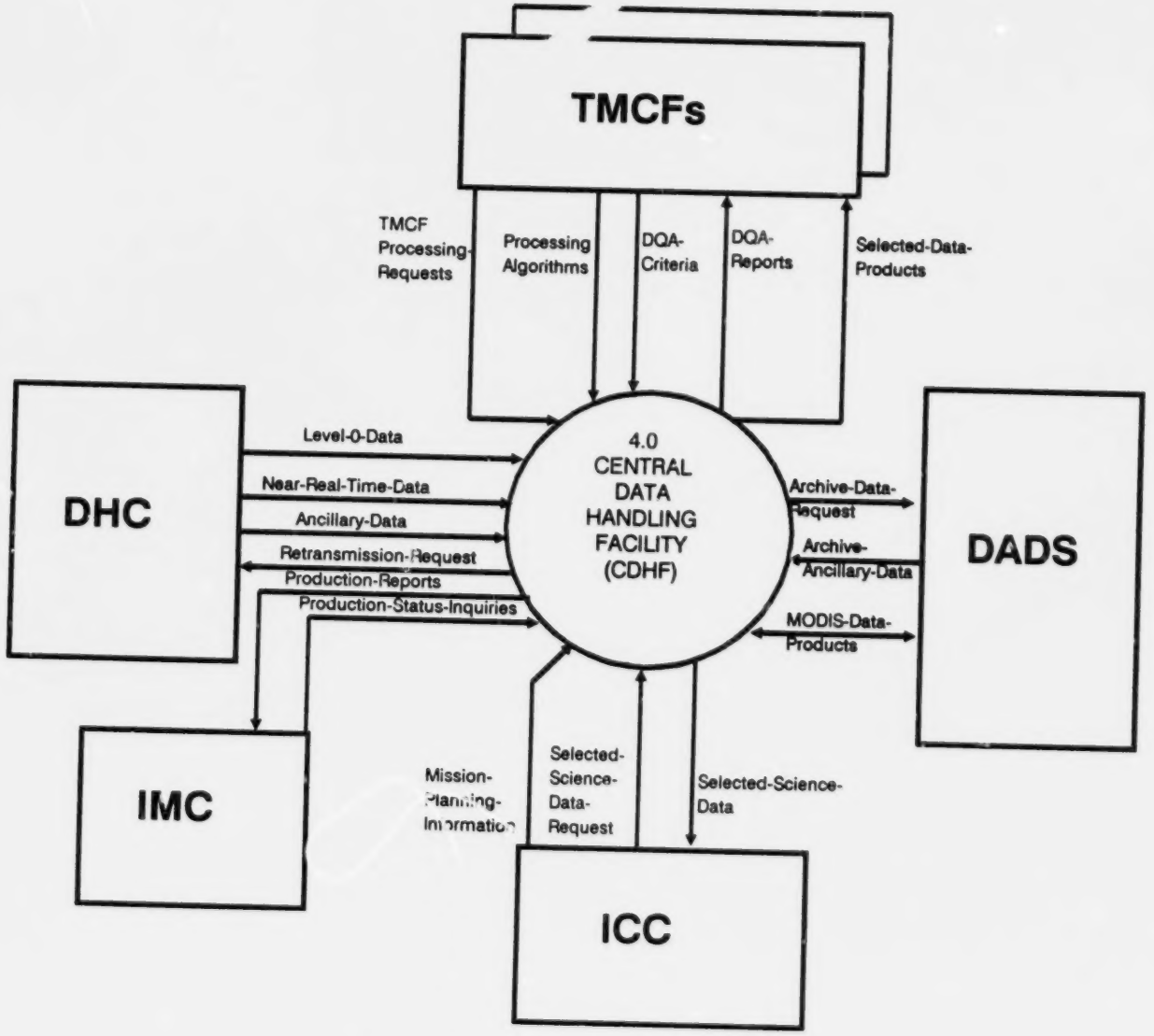


Figure 7. The CDHF Context Diagram

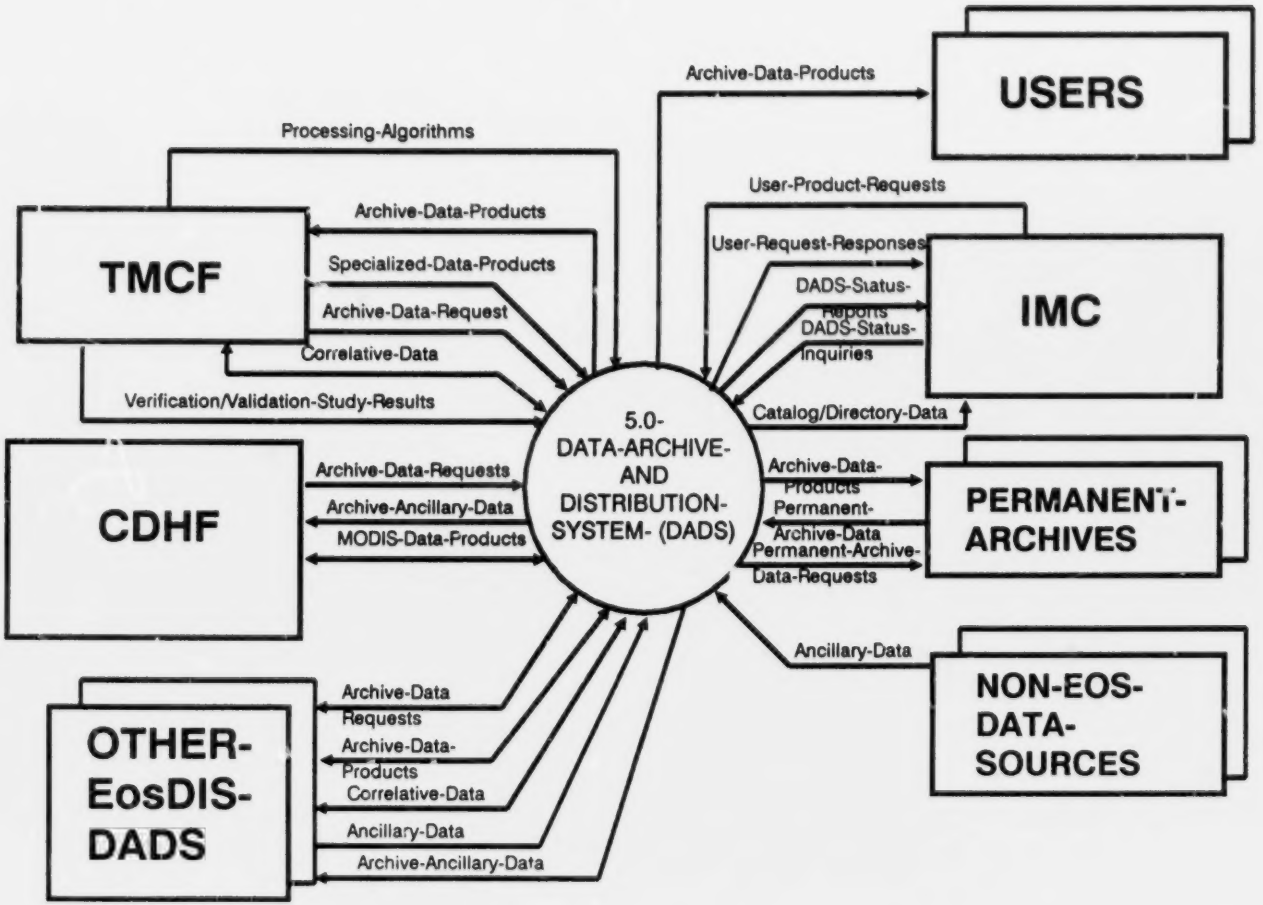
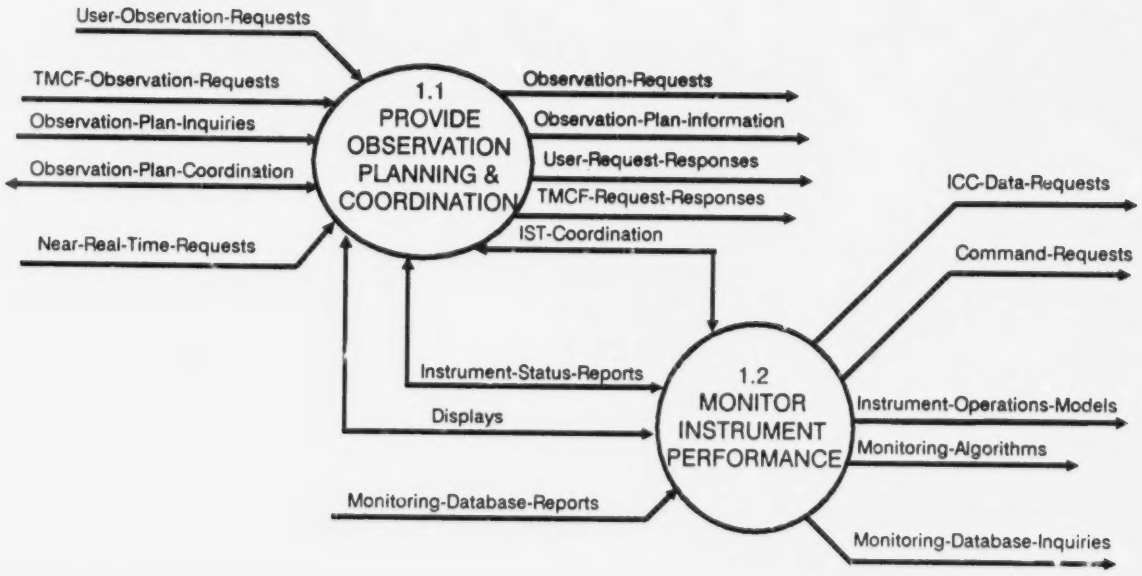


Figure 8. The DADS Context Diagram



DFD 1.0 IST Functional Data Flows

3.1.1 Observation Planning and Coordination

[See Data Flow Diagram 1.1: Provide Observation Planning and Coordination]

FNR7: The MODIS team leader shall be responsive to observation planning requests of the MODIS instrument from multi-disciplinary scientific entities. **SOURCE:** Reference 1 (derived from 2.1.1c).

FNR8: The MODIS team leader shall be responsive to requests from international entities for planning cooperative observational efforts of the MODIS instrument. **SOURCE:** Reference 1 (derived from 2.1.d).

FNR9: The MODIS team leader shall routinely collect and prioritize observation requests and shall regularly transmit such requests to the ICC for scheduling and command implementation. **SOURCE:** Reference 4 (Sections 3.2.2(5), 5.2 and 5.4.4).

3.1.1.1 *Planning Data*

FNR10: The IST shall receive and format science planning information from the MODIS users community, from MODIS team members, and from the ICC. **SOURCE:** Reference 18, IST Context Diagram and DFD 1.1.

3.1.1.2 *Observation Plan Coordination*

FNR11: The IST shall formulate a prioritized and coordinated MODIS observation plan from the received planning inputs. **SOURCE:** Reference 18, DFD 1.1.

FNR12: The IST shall be responsive to requests for science plan information from the user community. **SOURCE:** Reference 18, IST Context Diagram and DFD 1.1.

FNR13: The IST shall coordinate a request from a MODIS team member for priority handling designations for specific MODIS observation data. **SOURCE:** Reference 18, IST Context Diagram and DFD 1.1.

3.1.1.3 *Observation Requests*

FNR14: The IST shall convey formatted observation requests to the ICC. **SOURCE:** Reference 18, IST Context Diagram and DFD 1.1.

3.1.2 Instrument Performance Evaluation

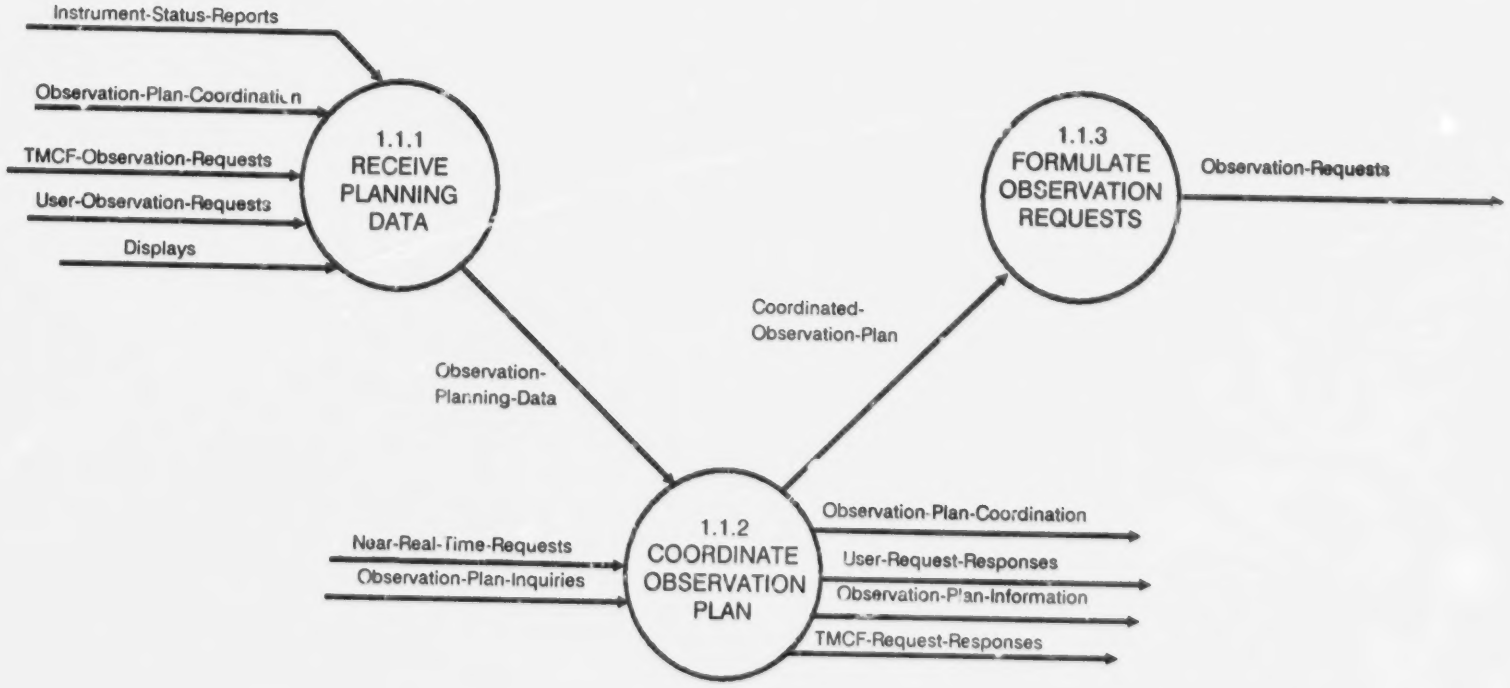
[See Data Flow Diagram 1.2: Monitor Instrument Performance]

FNR15: The MODIS team leader shall support the indoctrination and periodic training of ICC and IST personnel. **SOURCE:** Reference 1 (derived from 2.1.1f).

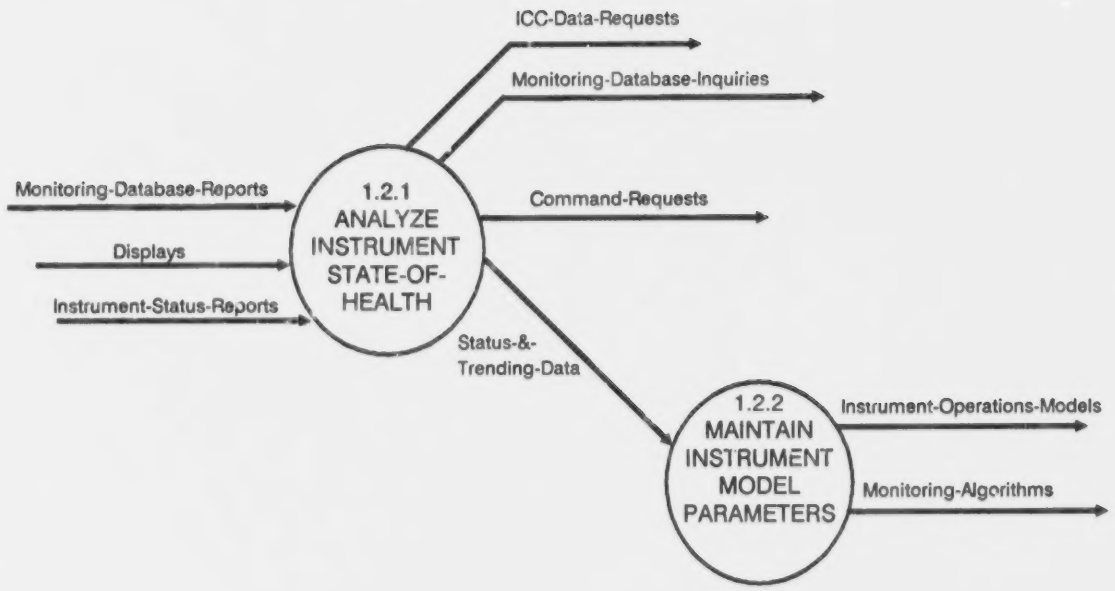
FNR16: The MODIS team leader shall define and test the MODIS operational scenarios and provide direction to the ICC for proper monitoring of the MODIS operation. **SOURCE:** Reference 4 (derived from 5.4.5).

3.1.2.1 *Instrument State-of-Health Analysis*

FNR17: The IST shall provide an assessment of the ongoing MODIS performance. **SOURCE:** Reference 4 (5.4.4).



DFD 1.1 Provide Observation Planning and Coordination



DFD 1.2 Monitor Instrument Performance

FNR18: The MODIS status indicators available at the ICC shall be available at the IST. **SOURCE:** Reference 4 (5.4.4).

FNR19: The IST shall send requests to the ICC for special calibration modes or changes in source parameters such as blackbody temperatures or a change in lamps. **SOURCE:** Reference B. Markham.

FNR20: The IST shall monitor MODIS operation to detect and react to uncharacteristic changes in detector response. The MODIS team leader and team members shall investigate such anomalies and recommend MODIS configuration and operational procedure changes to support the investigation. The IST shall approve MODIS operational changes to accommodate continued data collection. **SOURCE:** Reference 3 (5.2.2).

3.1.2.2 *Instrument Model Parameters Maintenance*

FNR21: The IST shall maintain a quick-look data set which bears on the calibration of the instrument, primarily to identify unexpected calibration changes which would affect the routine data processing. This data set shall provide the status of the onboard sources, their recent history, and the current and recent history of the instrument responses to the calibration sources. **SOURCE:** Reference B. Markham.

FNR22: The IST shall maintain an on-line summary of calibration coefficients presently being used in the routine data processing. **SOURCE:** Reference J. Barker.

3.2 INSTRUMENT CONTROL CENTER (ICC)

[See Data Flow Diagram 2.0: ICC Functional Data Flows]

FNR23: The MODIS Science Team shall use the ICC for operations. **SOURCE:** Reference 2 (ICC Facility).

3.2.1 Observation Planning and Scheduling

[See Data Flow Diagrams 2.1: Plan and Schedule Observations]

FNR24: The ICC shall have interactive control of the MODIS scheduling simulator from a console in the ICC. **SOURCE:** Reference 2 (ICC Facility) and derived from Reference 5, Req. 317.

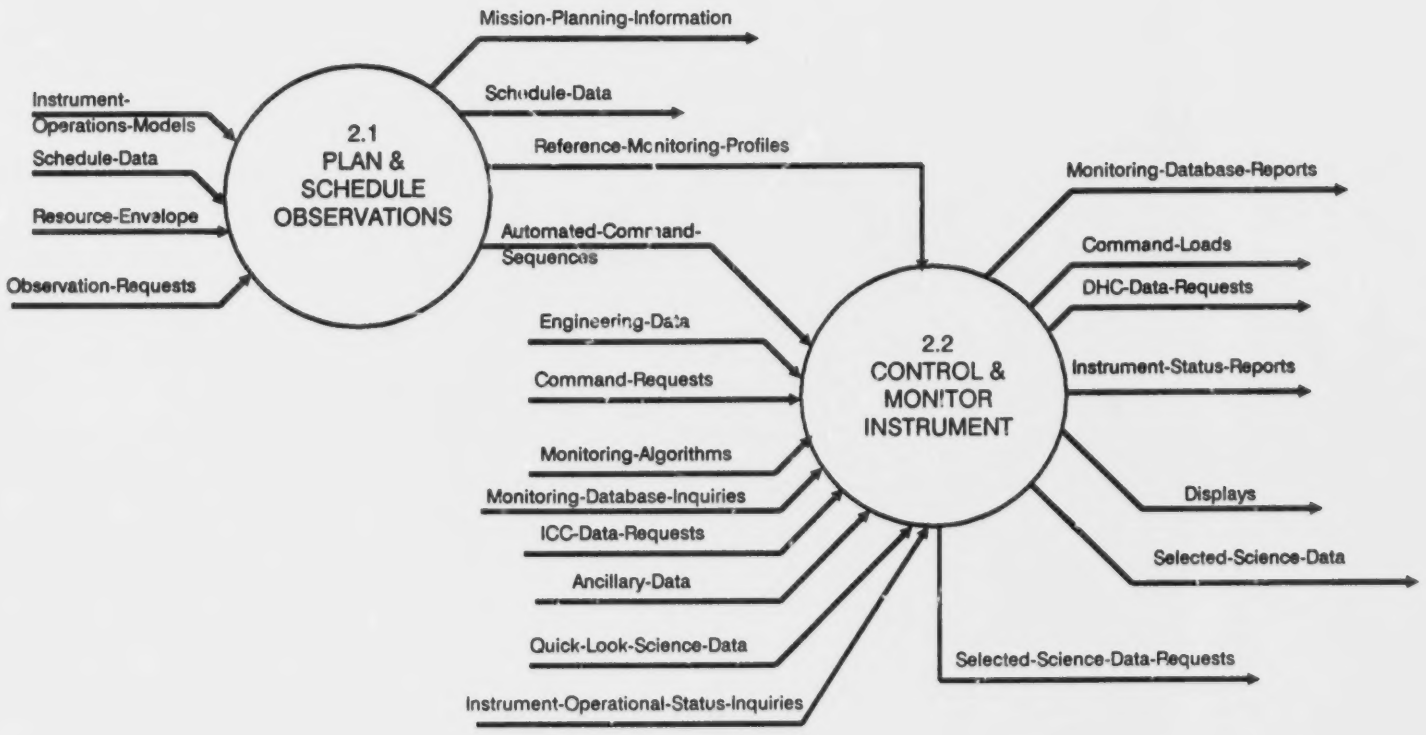
FNR25: The ICC shall provide coordination with authorized users (via the IST) in developing MODIS operation schedules. **SOURCE:** Reference 2 (ICC Facility).

3.2.1.1 *Observation Requests*

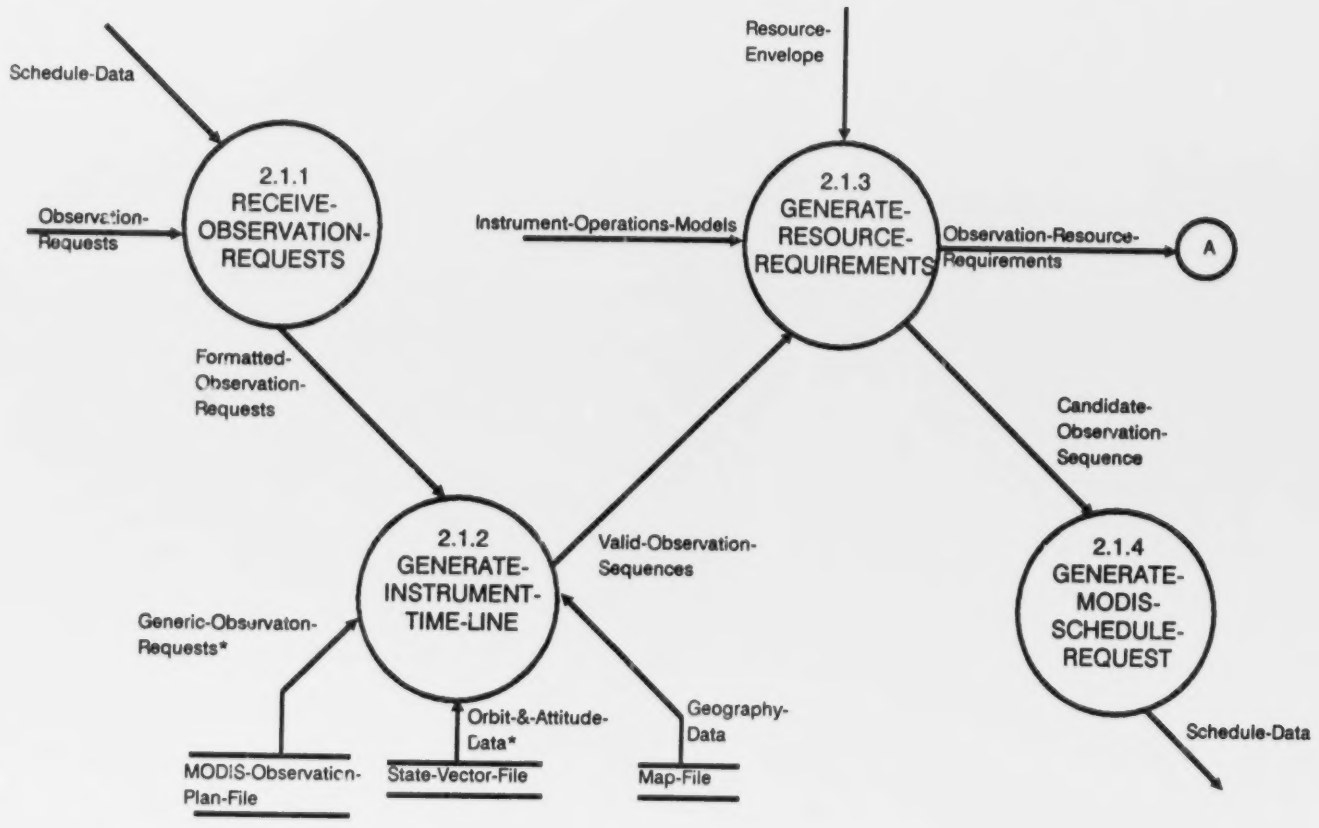
FNR26: The ICC shall receive observation planning and scheduling information in the form of a generic MODIS science plan from the IST/EMOC, an iterated schedule from EMOC and specific observation requests from the IST. This information shall be formatted into a sequence of observation requests. **SOURCE:** Reference 18, ICC Context Diagram and DFD 2.1.

3.2.1.2 *Instrument Time-Line Generation*

FNR27: The ICC manner of scheduling instrument activities shall accommodate changing user requirements, platform operating capabilities, satellite/Earth/Sun geometries, and cloud cover. **SOURCE:** Reference 2 (ICC Facility).

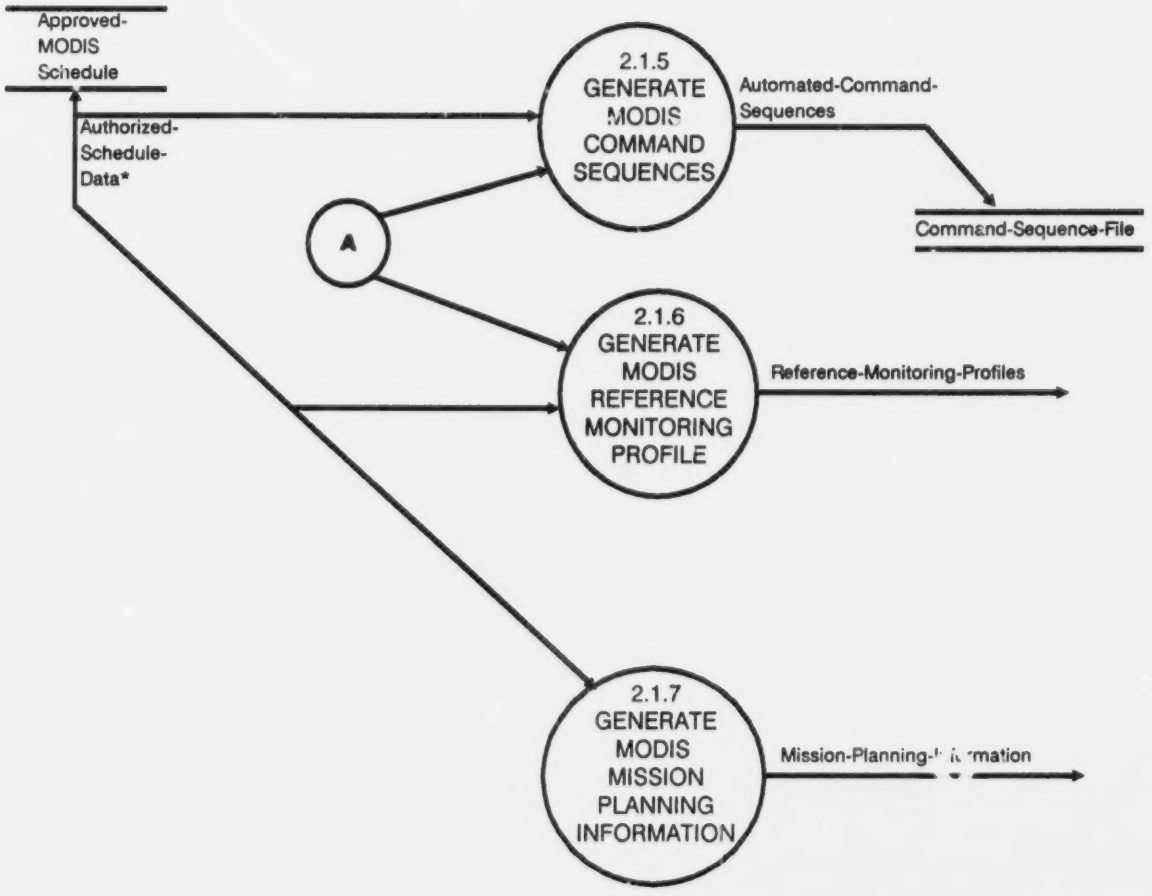


DFD 2.0 ICC Functional Data Flows



*Tentative. Issue under discussion.

DFD 2.1 Plan and Schedule Observations (1 of 2)



*Tentative. Issue under discussion.

DFD 2.1 Plan and Schedule Observations (2 of 2)

FNR28: The ICC shall verify observation requests from MODIS instrument users. **SOURCE:** Reference 12, p. 7.

FNR29: Instrument operations shall be in accordance with the schedule defined by the EMOC. Deviations without coordinating with the EMOC will occur only in the event of an instrument or platform anomaly for which a predefined procedure exists. **SOURCE:** Reference 2 (ICC Facility).

FNR30: The ICC shall have the capability to simulate MODIS instrument environmental considerations. **SOURCE:** Reference 7, Reqs 12-05 and 12-11.

FNR31: The ICC will define the MODIS instrument schedule within the resources and guidelines provided by the EMOC. **SOURCE:** Reference 2 (ICC Facility) and Reference 10, p. 6.

3.2.1.3 *Resource Requirement Generation*

FNR32: The ICC shall receive science plans and resource allocations from the EMOC. **SOURCE:** Reference 3, pp. 5-16 and Reference 10, p. 6.

FNR33: The ICC will simulate MODIS functional subsystems, including power, thermal, and tape recorder resources in determining scheduling resource requirements. **SOURCE:** Reference 7, Req 12-07 and from Reference 5, Req. 306.

3.2.1.4 *Schedule Request Generation*

FNR34: The ICC shall plan and generate instrument operation sequences needed to satisfy the EMOC integrated mission schedule. **SOURCE:** Reference 2 (ICC Facility).

FNR35: The ICC shall provide planning inputs to the EMOC. **SOURCE:** Reference 3 (2.3.2).

3.2.1.5 *Command Sequence Generation*

FNR36: The iterated scheduling of MODIS operations shall be automated and shall result in an automated command sequence in an instrument executable format. Such commands shall be released to the EMOC for transmittal to the platform. An image of these commands shall be retained in the ICC for use by the Control and Monitor function. **SOURCE:** Reference 18, ICC Context Diagram and DFD's 2.1 and 2.2.

3.2.1.6 *Reference Monitoring Profile Generation*

FNR37: The ICC's automated scheduling process shall result in a time-ordered image of the expected MODIS state and the expected values of instrumented telemetry. These expected values shall correspond exactly to the projected schedule of MODIS operations and shall, along with the image of commands, be made available to a Control and Monitor file and to the EMOC. **SOURCE:** Reference 18, ICC Context Diagram and DFD's 2.1 and 2.2.

3.2.1.7 *Mission Planning Information*

FNR38: The ICC's automated scheduler shall retain various mission planning data (to be specified) in the on-line ICC date base and shall be distributed to other MIDACS elements for use in their functional planning (e.g., CDHF discipline data production). **SOURCE:** Reference 18, ICC Context Diagram and DFD 2.1.

3.2.2 Instrument Control and Monitor

[See Data Flow Diagram 2.2: Control and Monitor Instrument]

FNR39: The ICC shall use TDRS for normal command and telemetry operations. In the event of a contingency that prevents the use of TDRS, they shall use the Command and Data Acquisition (CDA) stations. Use of the CDA stations shall be scheduled and coordinated with NOAA via the EMOC. **SOURCE:** Reference 2 (ICC Facility), Reference 3, p. 5-28.

FNR40: The ICC shall support the training of the MODIS instrument operations team. **SOURCE:** Reference 2 (ICC Facility).

FNR41: The ICC shall support simultaneous EOS on-orbit operations and EOS servicing mission tests and simulations. **SOURCE:** Reference 2 (ICC Facility).

3.2.2.1 *Instrument State-of-Health Monitoring*

FNR42: The ICC/IST shall provide the MODIS Instrument Scientist and/or his designated representatives the facilities to monitor the MODIS instrument performance by making available all the science instrument data in real time. **SOURCE:** Reference 19.

FNR43: Facilities for real-time MODIS instrument monitoring shall include two interactive workstations; one each for the MODIS-N and MODIS-T instruments. **SOURCE:** Reference 19.

FNR44: The scientist monitoring the real-time MODIS data shall be able to select, randomly or systematically, any four MODIS channels for simultaneous analysis for MODIS-N and for MODIS-T (a total of eight channels). **SOURCE:** Reference 19.

FNR45: Upon selection, data from the designated channels shall begin to build 2000 km x 2000 km scenes in the workstations' memory without delay. Once built, the scenes shall be continuously refreshed. **SOURCE:** Reference 19.

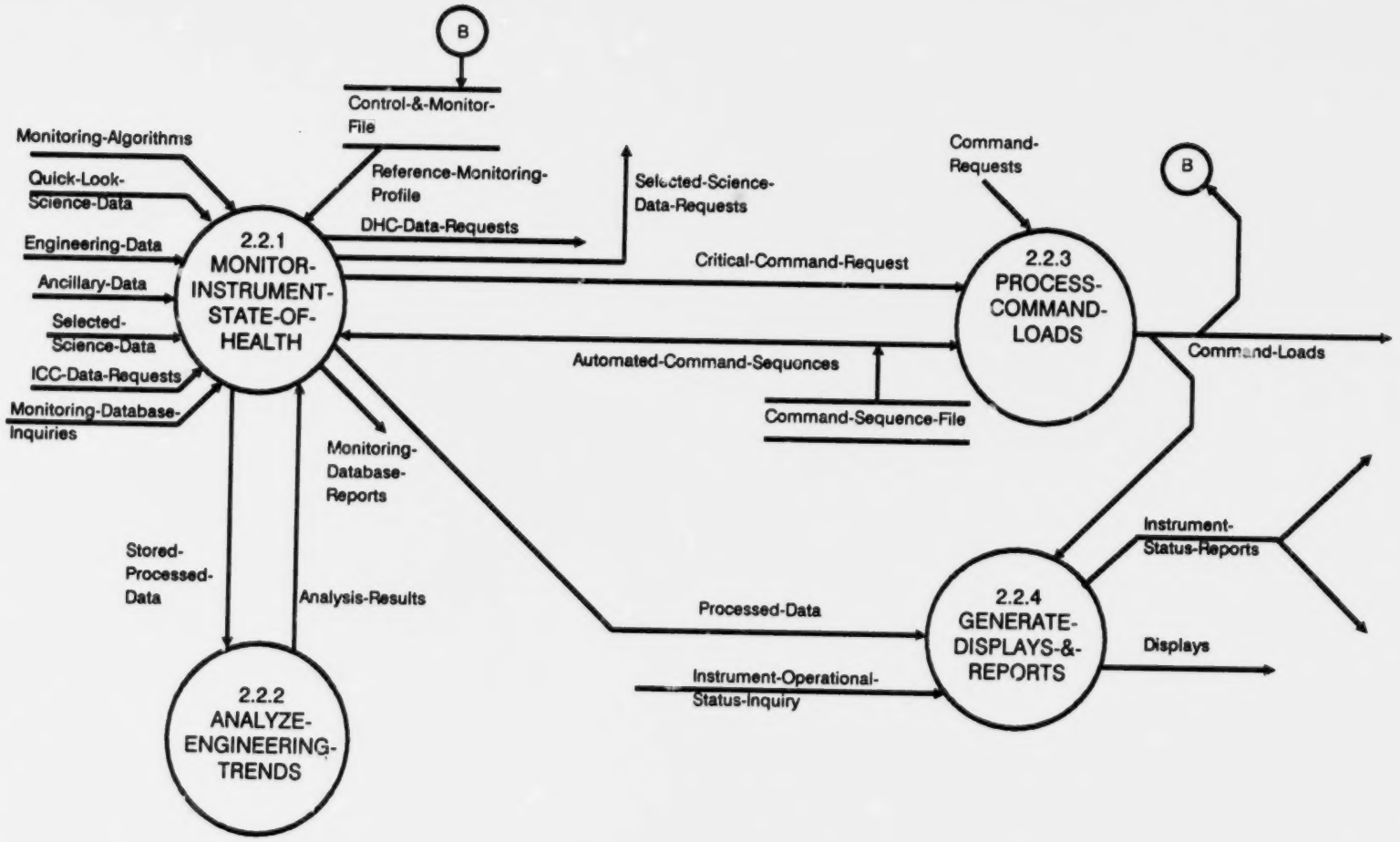
FNR46: The DHC shall supply to the ICC, and the ICC shall be designed to accept, the entire MODIS instrument data stream in either real-time or priority-playback mode. **SOURCE:** Derived from FNR44 and FNR45).

FNR47: Each workstation shall have sufficient internal RAM to store and manipulate the four scenes simultaneously (2,048 x 2,048 x 4 x 2 bytes) ---> more than 34 megabytes), as well as 200 megabytes of on-line storage, TBD off-line storage, and TBD hardcopy output devices. **SOURCE:** Reference 19.

FNR48: Each workstation shall be capable of performing TBD analysis of the data. **SOURCE:** Reference 19.

FNR49: The workstations shall be capable of simultaneously performing both the display and analysis functions. **SOURCE:** Reference 19.

FNR50: MODIS team members and support personnel shall have the capability to reconfigure observational sequences when malfunctions or special events occur. **SOURCE:** Reference 2 (ICC Facility).



DFD 2.2 Control and Monitor Instrument

FNR51: The ICC shall be capable of securing the MODIS instrument in the event of a problem that could endanger the instrument, other instruments, or the platform. **SOURCE:** Reference 2 (ICC Facility).

FNR52: The ICC shall generate real-time commands (i.e., ones that are sent directly to instrument via the EMOC without buffering or delay) in reaction to an anomaly that requires the instrument to be reconfigured. **SOURCE:** Reference 2 (ICC Facility).

FNR53: The ICC shall verify the receipt and correct execution of commands by the instrument for both real-time and stored commands. The ICC shall take appropriate action if notified that the command was not delivered. **SOURCE:** Reference 2 (ICC Facility).

FNR54: The ICC shall have a real-time and playback telemetry data processing system to monitor MODIS instrument status and to confirm responses to commands. **SOURCE:** Reference 2 (ICC Facility), Reference 3, p. 5-33.

FNR55: The ICC shall monitor the MODIS instrument telemetry data. This includes limit checks and configuration checks. Alarms will be generated in the event a discrepancy is detected. **SOURCE:** Reference 2 (ICC Facility).

FNR56: Ancillary data and data quality information shall be monitored in the ICC in the same manner as instrument telemetry data parameters. **SOURCE:** Reference 2 (ICC Facility).

FNR57: The ICC shall receive MODIS science data for quick-look evaluation if required to operate the MODIS instrument or to support the operation (e.g., support of field site operation). **SOURCE:** Reference 2 (ICC Facility).

FNR58: The ICC shall be capable of processing playback engineering data in packets whose order may be backwards. **SOURCE:** Reference 2 (ICC Facility).

FNR59: The ICC shall be capable of accepting real time and playback data simultaneously. **SOURCE:** Reference 2 (ICC Facility).

FNR60: The ICC shall receive packetized MODIS instrument engineering and ancillary data from the DHC. **SOURCE:** Reference 2 (DHC Facility, ICC Facility).

FNR61: The ICC shall support a quick-look capability of selected data in near-real-time to support on-going data monitoring. **SOURCE:** Reference 11, p. 7.

FNR62: Selected portions of the MODIS science data shall be forwarded to the ICC for evaluation. **SOURCE:** Reference 1, p. 7.

FNR63: The ICC shall monitor the health and safety of the MODIS instrument. **SOURCE:** Reference 3 (derived from 2.3.2).

FNR64: If problems occur, the ICC shall have the capability to trace the data flow back through the processing system to the instrument, aiding in the isolation and correction of these problems. **SOURCE:** Reference 6, p. 45.

3.2.2.2 *Engineering Trend Analysis*

FNR65: The ICC shall perform engineering trend analysis using MODIS and platform engineering data. **SOURCE:** Reference 2 (ICC Facility).

FNR66: MODIS instrument parameters should be monitored by examining its performance statistically. **SOURCE:** Reference 6, p. 45.

FNR67: The historical ICC data shall be archived in the event further analysis is required. **SOURCE:** Reference 3, p. 5-17 and Reference 8, p. 5-12.

FNR68: The ICC shall produce and maintain a MODIS instrument operations history which will include all commands, instrument status, and significant reconfigurations through the lifetime of the instrument. **SOURCE:** Reference 2 (ICC Facility); Reference 3, pp. 5-17; and Reference 5 (Req. 272).

3.2.2.3 *Command Processing*

FNR69: All command requests issued by the ICC to the EMOC shall consist of two parts: (1) the actual command load to be executed by the instrument; and (2) a description of what this command will do: power/thermal/tape recorder impacts, instrument mode, on/off times, data routes, movement/vibration. **SOURCE:** Reference 2 (ICC Facility) and Reference 3 (2.3.1).

FNR70: The ICC will receive command and observation requests from the MODIS IST. **SOURCE:** Reference 3, pp. 5-17 and Reference 10, p. 7.

FNR71: The ICC shall verify the emergency command request from the authorized MODIS team member or EMOC. **SOURCE:** Reference 12, p. 10.

FNR72: The ICC shall generate stored commands to execute the schedule. **SOURCE:** Reference 2 (ICC Facility).

FNR73: The ICC shall provide a new command sequence in response to a schedule change directed by the team leader of the MODIS instrument. **SOURCE:** Reference 2 (ICC Facility).

FNR74: The ICC shall validate the requested command load prior to sending it to the EMOC. **SOURCE:** Reference 3 (2.3.1).

FNR75: The ICC will check the loads to insure that no MODIS instrument constraints are violated, and that the operation does not exceed the resources allocated to it in the schedule. **SOURCE:** Reference 10, p. 6.

FNR76: The ICC shall store command loads necessary for MODIS instrument operation implementation. **SOURCE:** Reference 3, p. 5-16.

FNR77: The ICC shall modify the command loads in response to the identification of an approved target of opportunity. **SOURCE:** Reference 2 (ICC Facility).

3.2.2.4 *Displays and Status Reports*

FNR78: The ICC shall monitor the MODIS instruments' operation by processing and displaying MODIS instrument engineering data and platform ancillary data. **SOURCE:** Reference 2 (ICC) and Reference 10, p. 6.

FNR79: The MODIS instrument team members shall be able to monitor MODIS instrument data in near-real-time for quality assurance, error detection, and malfunction assessment. **SOURCE:** Reference 2 (ICC Facility).

FNR80: The ICC shall generate and forward to EMOC for distribution messages on the status of MODIS that are required in other control centers. **SOURCE**: Reference 2 (ICC Facility).

FNR81: The ICC will generate status data for any other control center that requires it. **SOURCE:** Reference 10, p.7.

FNR82: The ICC shall provide data quality reports to the IST giving the status of the various onboard calibration sources as well as instrument response to the sources. These status reports would include the following parameters:

1. Currents and voltages supplied to sources
2. Temperature of sources
3. Output of special sensor to monitor sources
4. MODIS instrument response

SOURCE: B. Markham.

3.3 TEAM MEMBER COMPUTING FACILITY (TMCF)

[See Data Flow Diagram 3.0: TMCF Functional Data Flows]

3.3.1 Develop and Maintain Science/Calibration Algorithms

[See Data Flow Diagram 3.1: Develop and Maintain Science/Calibration Algorithms]

FNR83: Team Members shall be responsible for the development and maintenance of the algorithms for the production of data sets and for the development of instrument calibration algorithms and coefficients. **SOURCE:** Reference 3, pp. 2-24, 5-8.

FNR84: The TMCF shall be composed of project provided computing resources at team member locations to be used in the development and test of algorithms. **SOURCE:** Reference 3, pp. 2-24, 5-13.

FNR85: The TMCF shall participate in the calibration of the MODIS instrument and incorporate calibration parameters in the data reduction procedure. **SOURCE:** Reference 3, p. 5-8.

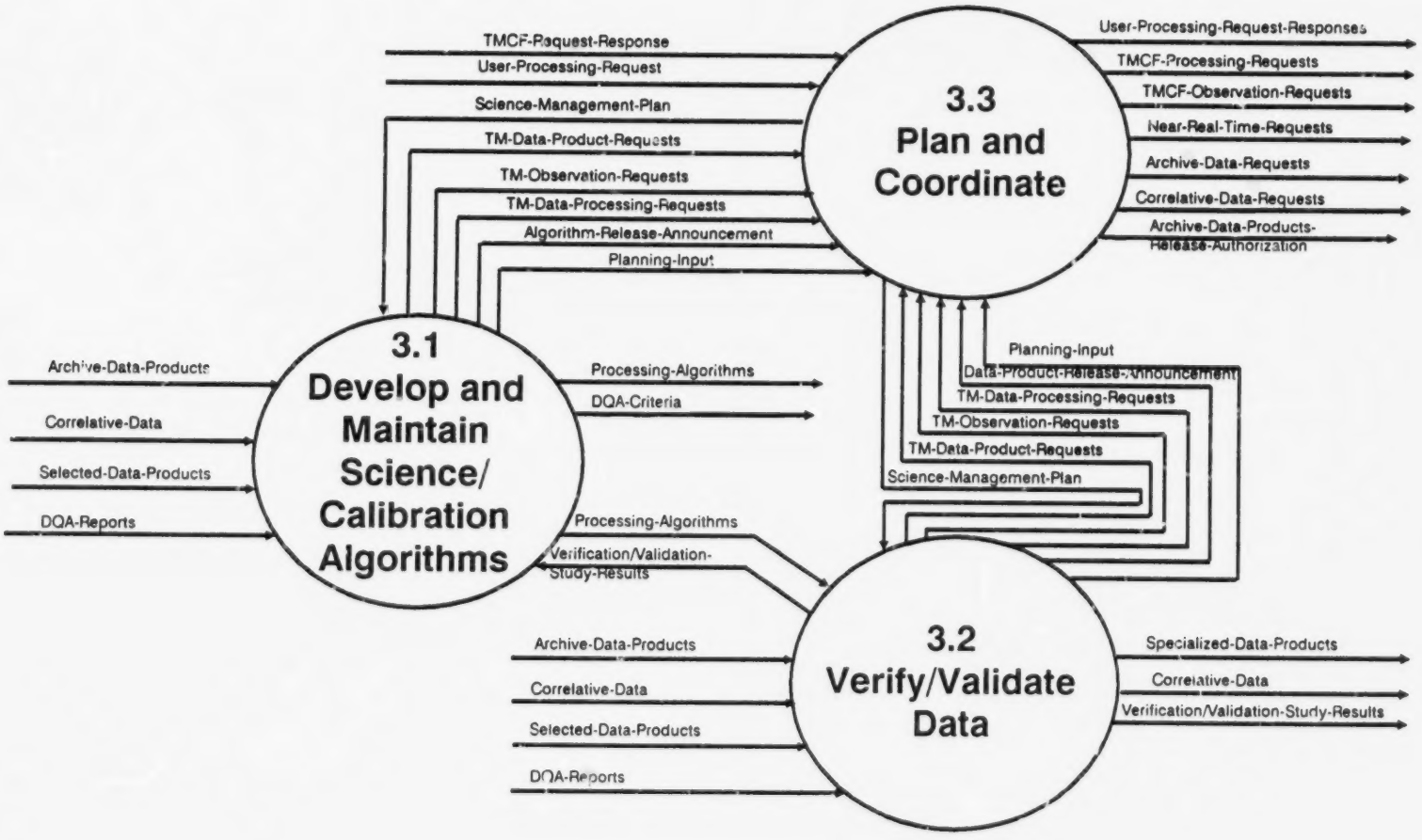
FNR86: A continuing program of algorithm verification and development in the TMCF must be maintained after launch. **SOURCE:** Reference 17, p. 50.

FNR87: A history of algorithm performance shall be maintained and accessible via the archives. **SOURCE:** Reference 6, Req. 93.

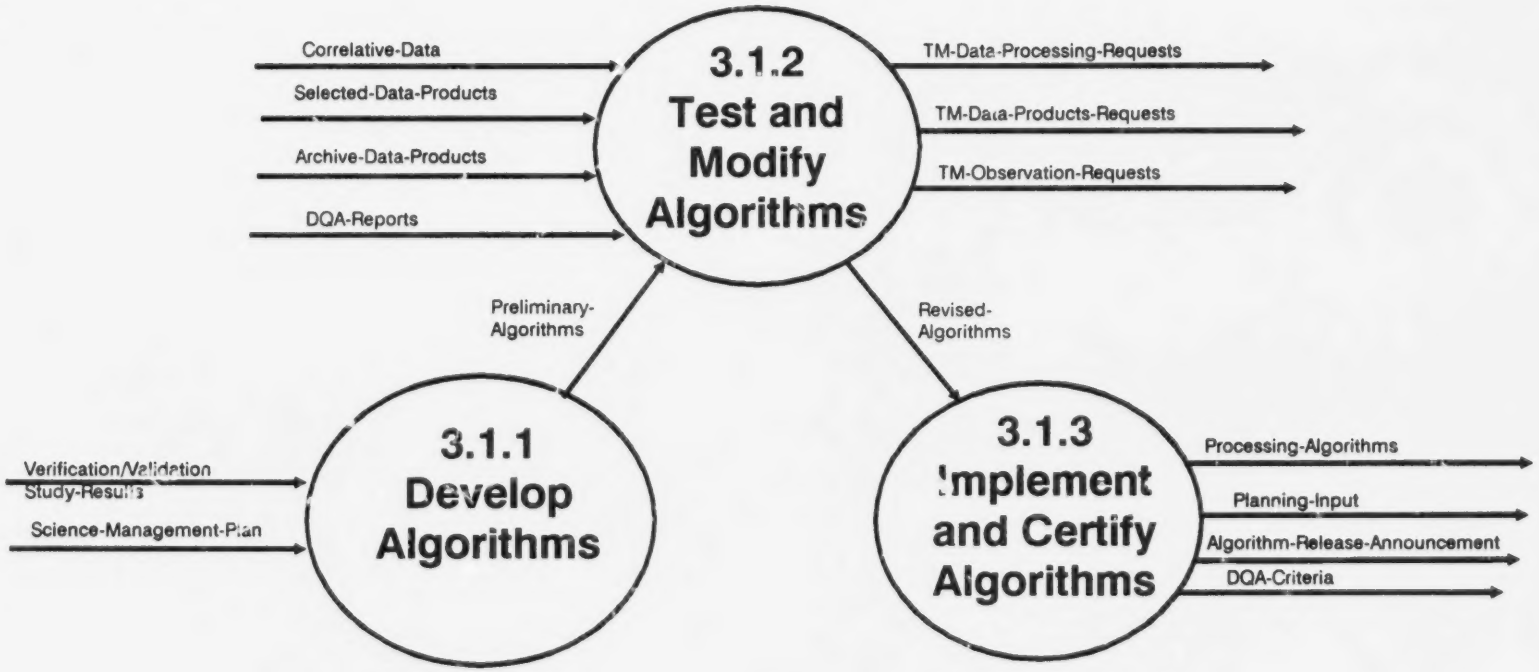
FNR88: The TMCF shall inspect raw Level-0 data during the pre-launch testing phase of MODIS-N and MODIS-T, and shall provide the results of these tests shall be provided to the DADS. **SOURCE:** Reference B. Markham.

3.3.1.1 *Develop Algorithms*

FNR89: The TMCF shall produce preliminary algorithms as part of the development of algorithms. **SOURCE:** Reference 18.



DFD 3.0 TMCF Functional Data Flows



DFD 3.1 Develop and Maintain Science/Calibration Algorithms

FNR90: The TMCF will use validation/verification study results and the Science Management Plan to develop algorithms. **SOURCE:** Reference 18.

3.3.1.2 *Test and Modify Algorithms*

FNR91: The TMCF shall accept correlative data, selected data products, archive data products, preliminary algorithms, and DQA reports as required for the testing and modification of algorithms. **SOURCE:** Reference 18.

FNR92: The TMCF shall generate data processing requests, data product requests, and observation requests as required for the testing and modification of algorithms. **SOURCE:** Reference 18.

FNR93: The TMCF shall produce revised algorithms as part of the testing and modification of algorithms. **SOURCE:** Reference 18.

3.3.1.3 *Implement and Certify Algorithms*

FNR94: The TMCF shall provide a temporary storage of algorithms used in the analysis of the data. **SOURCE:** NEW1.

FNR95: The TMCF shall certify revised processing algorithms prior to their implementation at the CDHF. **SOURCE:** Reference 18.

FNR96: The TMCF shall provide processing algorithms, planning input, and algorithm release announcements as part of the implementation and certification of algorithms. Reference 18.

3.3.2 **Verify/Valiuation Data**

[See Data Flow Diagram 3.2: Verify/Validate Data]

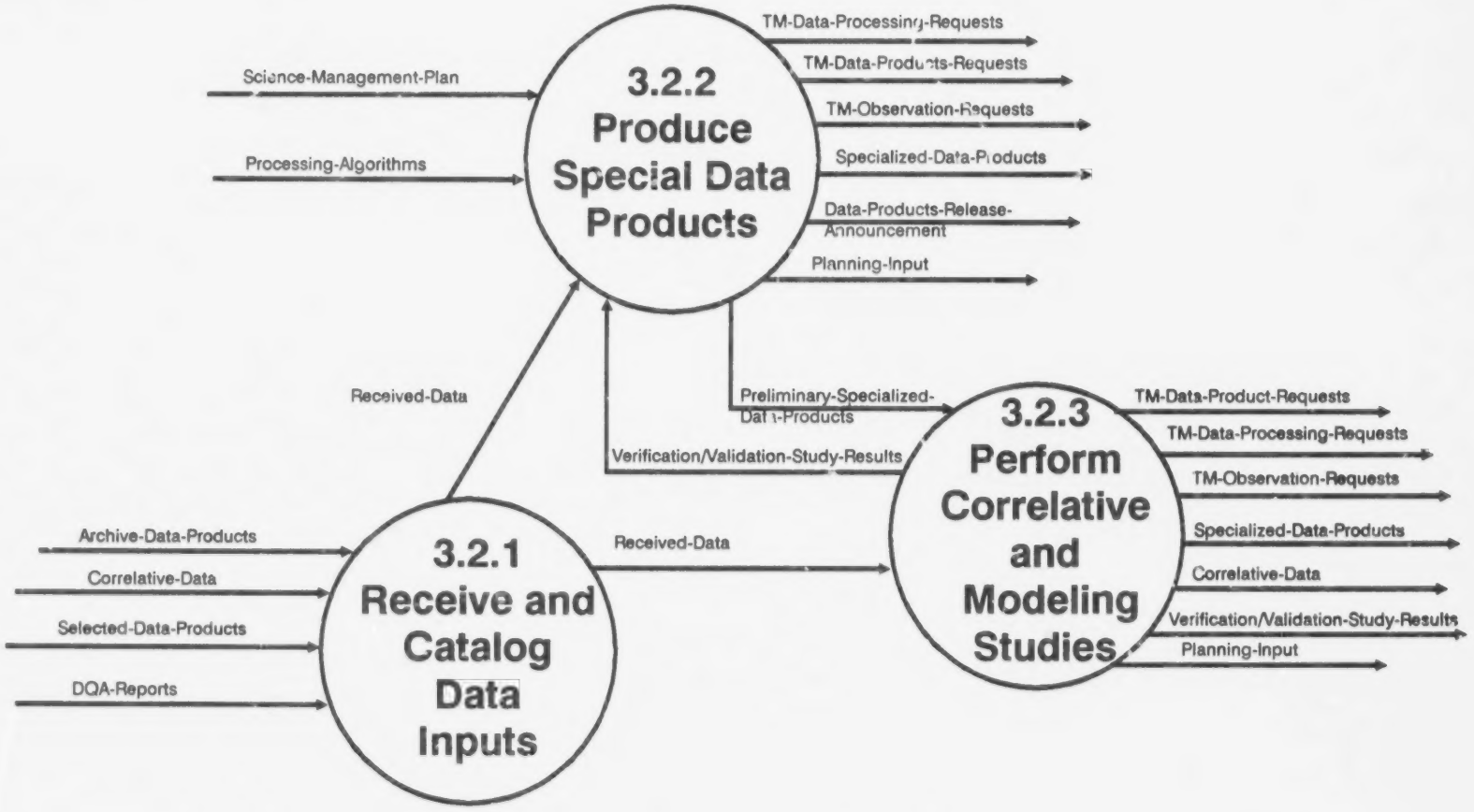
FNR97: Communications capabilities shall be embedded into the data system so as to enable the delivery of near-real-time scene data to the investigators at the site of the experiments (within the specified timeliness requirements). **SOURCE:** Reference 19.

FNR98: Computing resources shall be made available to the investigators at the site of the experiment (perhaps as portions of the distributed TMCF) to enable in-situ analysis of the MODIS data products. **SOURCE:** Reference 19.

FNR99: The TMCF shall be project provided computing resources at team member locations to be used in data investigations and the validation of data. **SOURCE:** Reference 3, pp. 2-24, 5-13.

FNR100: During the MODIS mission lifetime, the calibration of the instrument shall be maintained by the Calibration Support Team using TMCF with specific consideration of the absolute radiometric accuracy, absolute radiometric accuracy of polarization measurements, maximum allowable root-mean-square (rms) noise, detector to detector uniformity, spectral band to spectral band radiometric accuracy and long-term stability. **SOURCE:** Reference 14.

FNR101: Prior to launch the Calibration Support Team using the TMCF shall assure that the calibration of the MODIS instrument meets the Science Team specifications such as spectral coverage, spectral band separation, polarization sensitivity, Stokes parameter derivation in polarization studies, instrument field of view, focal plane configuration, system



DFD 3.2 Verify/Validate Data

modulation transfer function, dynamic range, sensitivity, and quantization, linearity, radiometric accuracy, and onboard source characterization. **SOURCE:** Reference 14.

FNR102: The Calibration Support Team shall assure that the calibration is accurate to within two percent and stable over time. **SOURCE:** Reference 14.

FNR103: Data taken by the onboard radiometric and spectral calibration systems for MODIS shall be used to maintain the calibration, such as 1) an onboard spectral response calibrator, to monitor sensor spectral response changes, 2) uniform, stable and known irradiance sources for all sensors passing through the entire optical system, and 3) inherently stable sources and/or use of a separate system to monitor source stability. **SOURCE:** Reference 14.

FNR104: The onboard calibration sequence shall include calibration of the sensor electronics and Calibration Support Team shall assure these calibrations are maintained. **SOURCE:** Reference 14.

3.3.2.1 *Receive and Catalog Data Inputs*

FNR105: The TMCF shall receive and catalog archive data products from the DADS required for the validation and verification of data. **SOURCE:** Reference 18.

FNR106: The TMCF shall receive and catalog correlative data products from the DADS required for the validation and verification of data. **SOURCE:** Reference 18.

FNR107: The TMCF shall receive and catalog selected data products from the CDHF required for the validation and verification of data. **SOURCE:** Reference 18.

FNR108: The TMCF shall receive and catalog DQA reports from the CDHF as required for the validation and verification of data. **SOURCE:** Reference 18.

3.3.2.2 *Produce Special Data Products*

FNR109: The production, short-term storage, and dissemination of scientifically useful data sets shall be performed by the TMCF. **SOURCE:** Reference 3, p. 5-9.

FNR110: Higher level data sets shall be tagged with an identifier for the algorithm used to generate the data from lower level data. Identifiers shall also be retained for the lower level algorithms, calibration constants, and engineering data that were used to generate the lower level data on which the higher level processing is based. **SOURCE:** Reference 2, Ch. VI.

FNR111: TMCF investigators must return results of their analyses to the system. Additional processing of the data, resulting from the investigation, shall be required to provide: 1) a catalog entry containing descriptions of the data sources, data properties, analysis methods, and attributes (e.g, location, time, wavelength), 2) a standard format to allow access from EosDIS software and processing by EosDIS archival software, 3) documentation of data set contents, processing algorithms, and instrument characteristics, and 4) an evaluation of the results, including error analyses and validation tests, as well as a relevant library. **SOURCE:** Reference 6, p. 27.

FNR112: The TMCF shall function according to the science management plan in the production of special data products. **SOURCE:** Reference 18.

FNR113: The TMCF shall use received data, processing algorithms, and validation/verification study results in the production of special data products. **SOURCE:** Reference 18.

FNR114: The TMCF shall generate data processing requests, data product requests, and observation requests required for the production of special data products. **SOURCE:** Reference 18.

FNR115: The TMCF shall provide data product archive release authorizations. **SOURCE:** Reference 18.

FNR116: The TMCF shall produce preliminary specialized data products prior to the production of special data products. **SOURCE:** Reference 18.

FNR117: The TMCF shall provide planning input concerning the production of special data products to the science management plan. **SOURCE:** Reference 18.

3.3.2.3 *Perform Statistical Studies and Modeling*

FNR118: The TMCF shall participate in intercomparisons of calibrated instruments such as a comparison of MODIS to HIRIS. **SOURCE:** Reference 15.

FNR119: The TMCF shall generate data product requests and data processing requests when performing statistical studies and modeling. **SOURCE:** Reference 18.

FNR120: The TMCF shall receive archive data products, correlative data products, and selected data products, and DQA reports when performing statistical studies and modeling. **SOURCE:** Reference 18.

FNR121: The TMCF shall produce specialized data products, validation/verification study results, and planning input when performing statistical studies and modeling. **SOURCE:** Reference 18.

3.3.3 Plan and Coordinate

[See Data Flow Diagram 3.3: Plan and Coordinate Support]

FNR122: The Team Leader shall develop a plan in conjunction with the team members which describes the data delivery obligations of the Team to the EosDIS. **SOURCE:** Reference 3, p. 5-9.

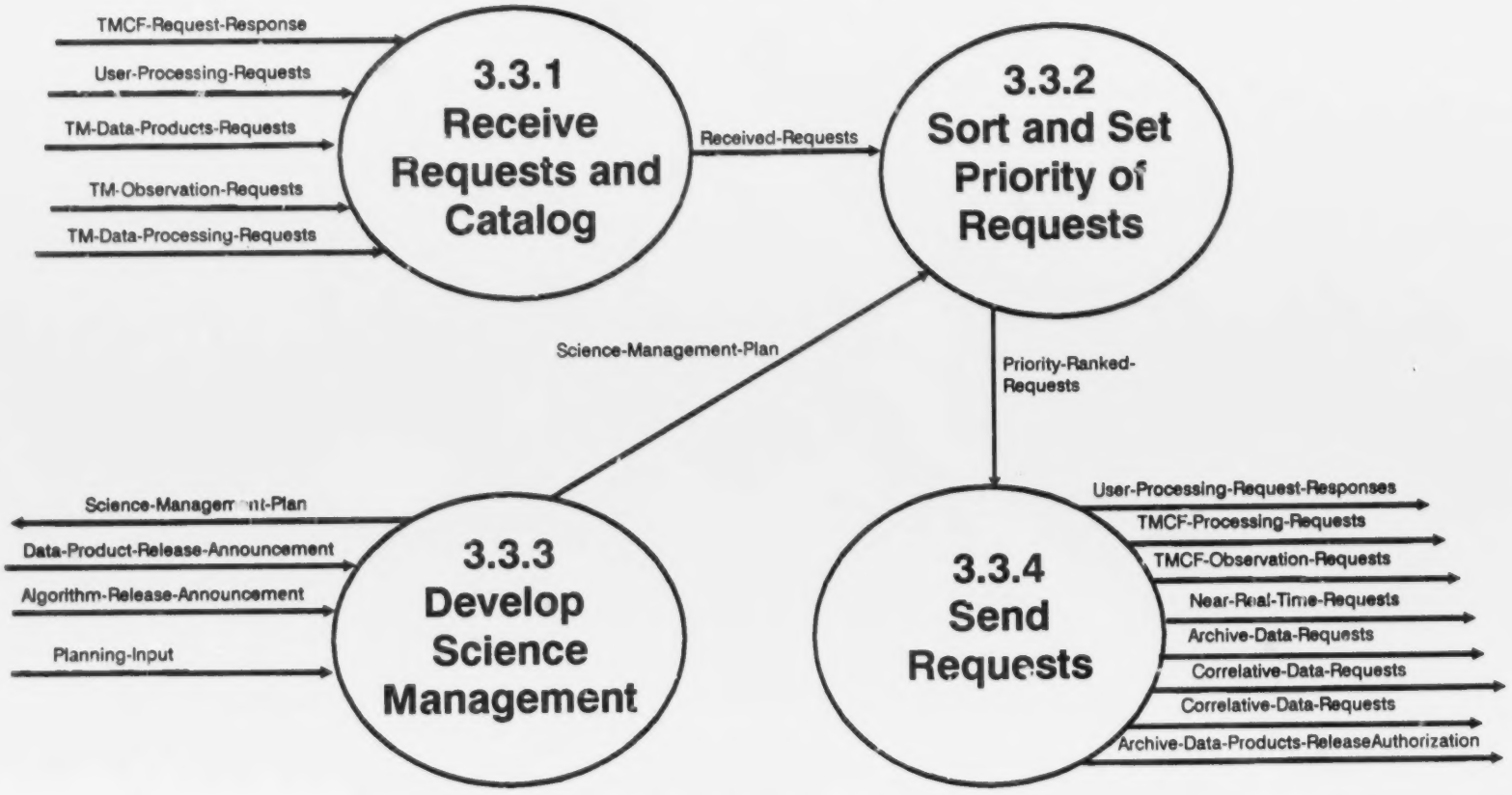
3.3.3.1 *Receive Requests and Catalog*

FNR123: The TMCF shall receive and catalog team member and user processing requests, data product requests, and observation requests, as part of planning and coordination. **SOURCE:** Reference 18.

FNR124: The TMCF shall produce received requests as part of planning and coordination. Reference 18.

3.3.3.2 *Sort and Set Priority of Requests*

FNR125: The TMCF shall sort and prioritize all received requests as part of planning and coordination. **SOURCE:** Reference 18.



DFD 3.3 Plan and Coordinate Support

FNR126: The TMCF shall use the science management plan as a guide for the sorting and prioritization of requests. **SOURCE:** Reference 18.

FNR127: The TMCF shall provide team members and MIDACS with priority ranked requests as part of sorting and prioritization of requests. SOURCE Reference 18.

3.3.3.3 *Develop Science Management Plan*

FNR128: The Team Leader shall develop a Science Management Plan (including the assignments and responsibilities of each team member), which shall be updated at least once per year. **SOURCE:** Reference 3, p. 5-7.

FNR129: The team leader shall consider planning input for the development of the science management plan from both team members and outside sources. **SOURCE:** Reference 18.

FNR130: The team leader shall accept data product release announcements and algorithm release announcements as input for the development of the science management plan. **SOURCE:** Reference 18.

3.3.3.4 *Send Requests*

FNR131: The TMCF shall distribute priority ranked team member and user request responses to the IMC as part of planning and coordination. **SOURCE:** Reference 18.

FNR132: The TMCF shall distribute priority ranked TMCF processing requests to the CDHF as part of planning and coordination. **SOURCE:** Reference 18.

FNR133: The TMCF shall distribute priority ranked TMCF observation requests to the IST as part of planning and coordination. **SOURCE:** Reference 18.

FNR134: The TMCF shall distribute priority ranked archive data requests to the DADS as part of planning and coordination. **SOURCE:** Reference 18.

FNR135: The TMCF shall distribute priority ranked correlative data requests to the non-EOS data sources as part of planning and coordination. **SOURCE:** Reference 18.

3.4 CENTRAL DATA HANDLING FACILITY (CDHF)

[See Data Flow Diagram 4.0: CDHF Functional Data Flows]

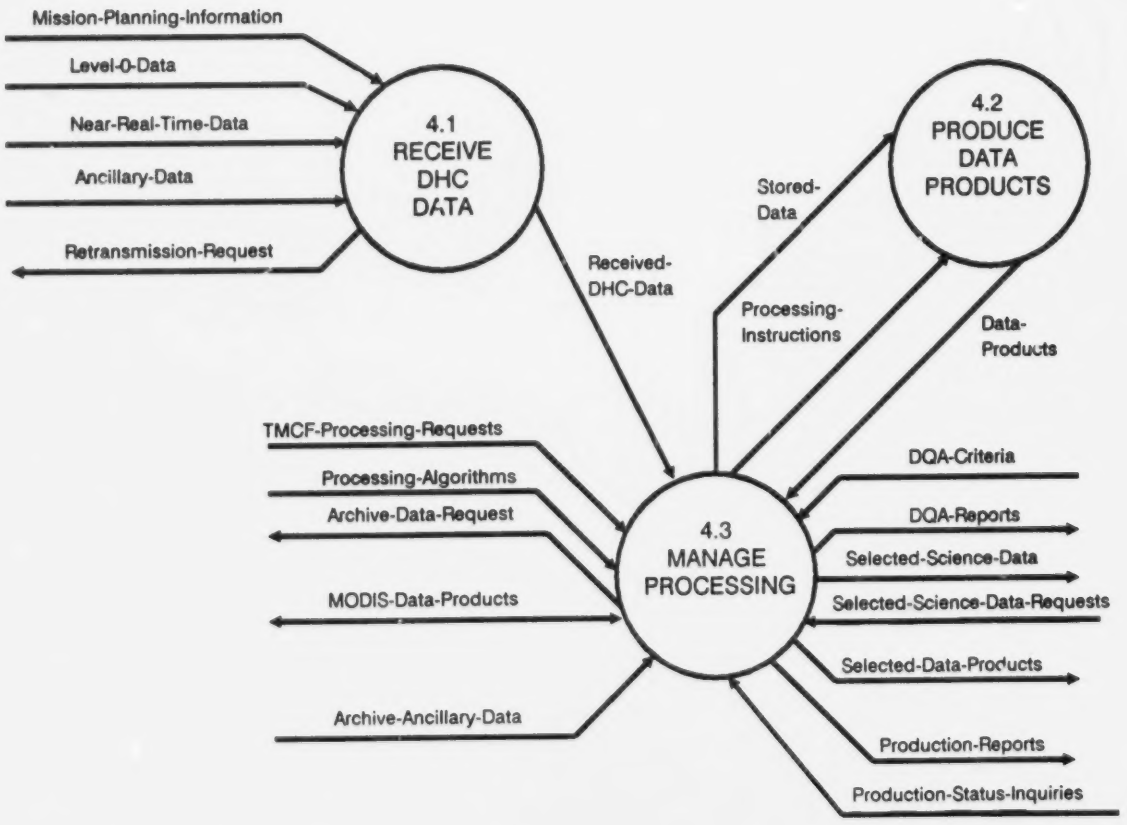
3.4.1 Receive DHC Data

[See Data Flow Diagram 4.1: Receive Data]

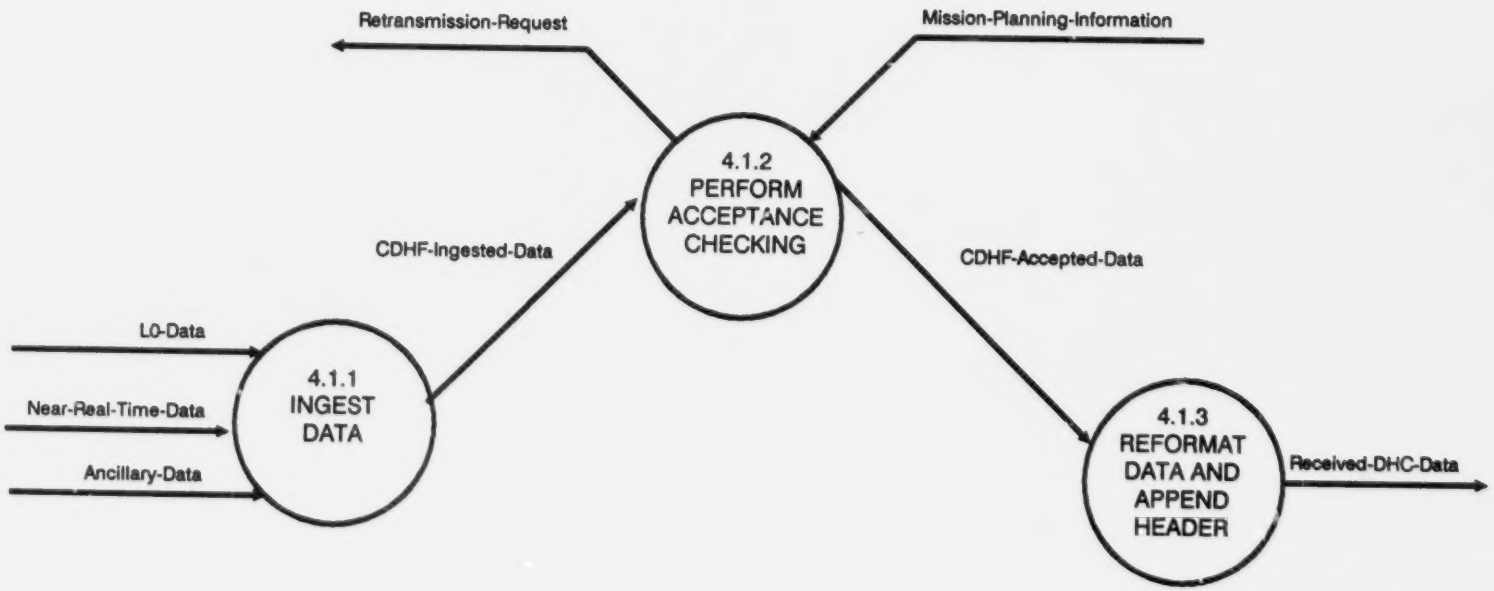
3.4.1.1 *Ingest Data*

FNR136: The CDHF shall accept MODIS Level-0 data from the DHC. **SOURCE:** Reference 3, pp. 2-8 and 5-29.

FNR137: The CDHF shall receive Level-0 data and ancillary data from the DHC. The Level-0 data shall be in a form that is sequenced by time, by focal plane, by along-track distance, and by band configuration along the scan direction. Ancillary data shall have been checked, at the DHC, against high and low limits, and validated by comparisons



DFD 4.0 CDHF Functional Data Flows



DFD 4.1 Receive Data

with orbit and attitude reference profiles. The Level-0 data shall have been transmission error corrected and redundancies removed. **SOURCE:** Reference 20 and Reference 3, pp. 2-8 and 5-79.

FNR138: The Level-0 data shall contain:

a. Instrument science data in the form of digital counts
b. Calibration target data taken at most once per scan
c. Instrument engineering data

FNR139: The ancillary data shall include:

a. Time and spacecraft ephemeris
b. Spacecraft attitude and/or instrument attitude
c. Platform engineering data
d. Other ancillary data

FNR140: The CDHF shall accept MODIS Level-0 data, most of which are TBD bits in length and packed.

3.4.1.2 *Perform Acceptance Checking*

FNR141: The CDHF shall perform TBD acceptance checking of Level-0 data and request any necessary retransmission of data from the DHC. **SOURCE:** Reference 20.

3.4.1.3 *Reformat Data and Append Header*

FNR142: The CDHF shall perform any necessary reformatting of received Level-0 data and will append standard headers. **SOURCE:** Reference 20.

3.4.2 Produce Data Products

[See Data Flow Diagram 4.2: Produce Data Products]

FNR143: The basic Levels-2, -3, and -4 data product time spans shall be TBD.

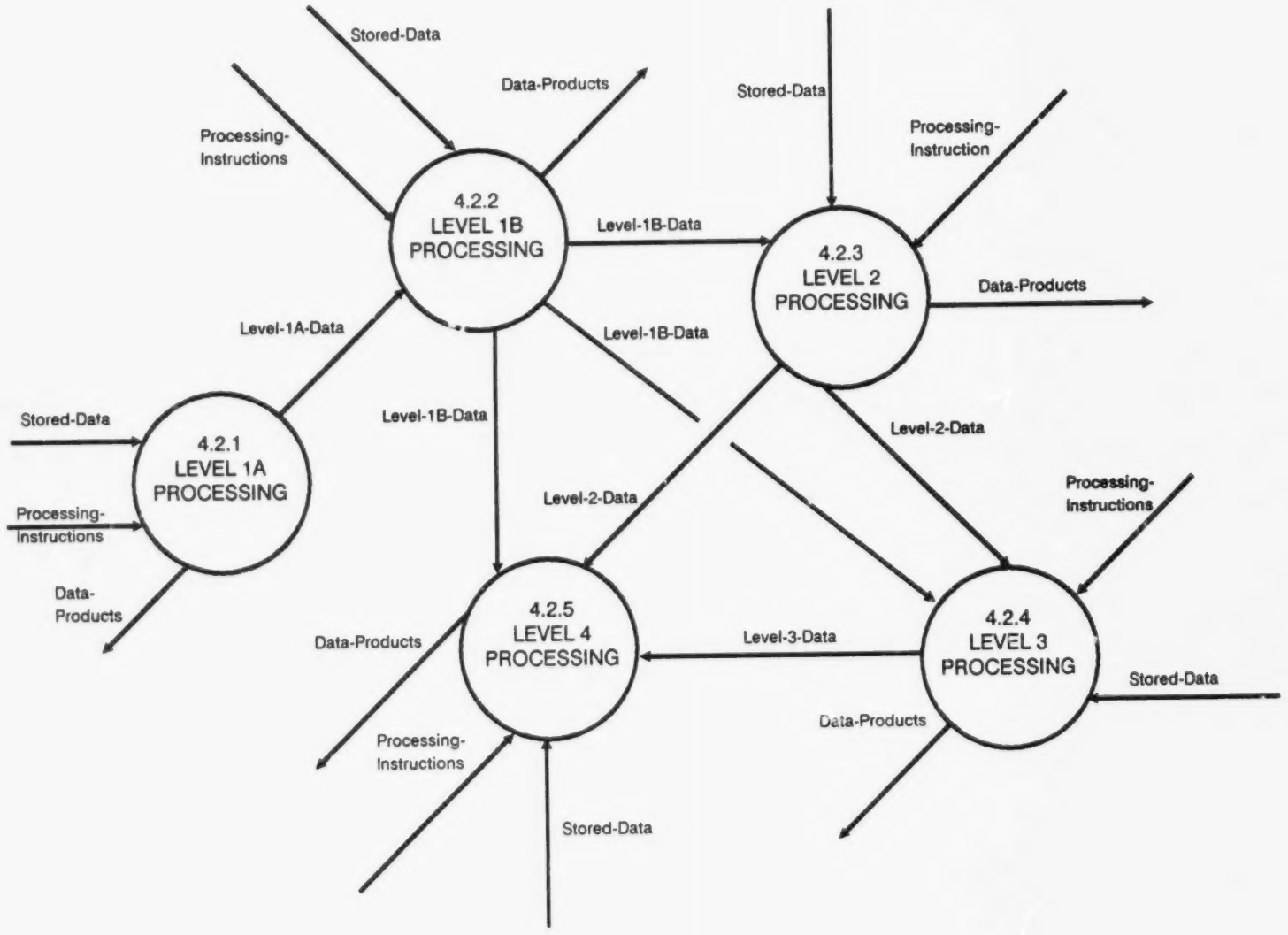
FNR144: The spatial and temporal resolution of scientific parameters contained in the Levels-2, -3, and -4 data products shall be TBD.

FNR145: The Levels-3 and -4 data product formats shall be TBD.

FNR146: The Levels-1, -2, -3, and -4 data products shall have appended to the various levels of data organization (from the basic product length to the lowest level of segmentation or gridding), TBD-appended information from the lower level input data, geophysical parameter identification(s), geophysical parameter algorithm version identification(s), gridding description and statistics for Level-3, correlative data information for Level-4, geophysical or applications model identification for Level-4, data quality assessment information, processing date, and version number.

FNR147: The word sizes for Levels-2, -3, and -4 data products are TBD.

FNR148: TBD data compression shall be applied to TBD Levels-2, -3, and -4 products.



DFD 4.2 Produce Data Products

FNR149: Higher level data shall be tagged with an identifier for the algorithm used to generate the data from lower level data. Identifiers shall also be retained for the lower level algorithms, calibration constants, and engineering data that were used to generate the lower level data on which the higher level processing is based. **SOURCE:** Reference 20.

FNR150: The Levels-1, -2, -3, and -4 processors shall each be capable of performing reprocessing, special requests, near-real-time, and backlog processing, in addition to the standard processing of playback data. **SOURCE:** Reference 20.

FNR151: Levels-1, -2, -3, and -4 products shall contain all of the information necessary for the creation of catalogs and inventories of Levels-1, -2, -3, and -4 data, and this information should be passed on to the next level of processing. **SOURCE:** Reference 20.

FNR152: The time span of the basic Level-1 product is TBD, but may be multi-day, daily, orbital, or a fraction of a day, etc. **SOURCE:** Reference 20.

FNR153: The Level-1 processor shall organize the science data into logical data records that are TBD. The natural blocking of the MODIS data is by observation swath (64 km x 1780 km for MODIS-T and 8 km x 1780 km for MODIS-N). Note that calibration reference data are taken, at most, once per swath or scan. The requirement of putting one full swath into the memory of a processor may be too stringent for many users. It is anticipated that a strategy shall be developed to break swaths into smaller pieces (segmentation). Any segmentation strategy should have the following characteristics:

a. Each segment should be preceded by a segment description header.

b. Each segment should be made as complete as possible in terms of Earth location and calibration of the pixels.

c. Segmentation should promote ease of the next level of processing.

SOURCE: Reference 20.

FNR154: The organization of the Levels-1A and -1B data within a swath shall be spectral channel sequential (i.e., sequential pixels in all scan lines within a swath shall be from the same channel). **SOURCE:** Reference 20.

FNR155: The Levels-1A and -1B data products shall have appended to the various levels of data organization (from the basic product length to the lowest level of segmentation) subsets of the following ancillary data (the resolutions in time and space are TBD):

a. MODIS-N/MODIS-T sensor identification
b. Product sequence number/version number
c. Processing date
d. Calibration algorithm identification number/version number
e. Product start and stop times
f. Orbit number(s)
g. Geographical boundaries of the product
h. Channel identification
i. Data quality flags
j. Calibration quality flags
k. Housekeeping data
l. Engineering data
m. Land/ocean flags
n. Measure of cloudiness

o. Instrument tilt information (MODIS-T)
p. Scan number(s)
q. Attitude information
r. Platform ephemeris
s. Time code
t. Solar and satellite zenith angle information
u. GPS time correction
v. Platform structure telemetry
w. Calibration coefficients (Level-1B)
SOURCE: Reference 20.

FNR156: There shall be separate Levels-1A and -1B calibration data products which shall consist of data taken during calibration modes (i.e., when the sensor views the diffuser plate, calibration blackbodies, etc.). **SOURCE:** Reference 20.

FNR157: The data quality software shall detect and record significant instrument performance changes. **SOURCE:** Reference 6, page 25.

FNR158: The CDHF shall assess the quality of science data in near-real-time for selected samples of data. **SOURCE:** Reference 5, p. B-13.

FNR159: The CDHF shall produce TBD browse images. **SOURCE:** Reference 20.

FNR160: The CDHF shall support image resampling and enhancement of calibrated image data sets. **SOURCE:** Reference 7, p. 5-28.

FNR161: The CDHF shall support data reduction, grid overlay, standard projection data set production, and data set merger. **SOURCE:** Reference 6, page vii.

3.4.2.1 *Process Level-1A*

FNR162: Until reversibility of the calibration process is demonstrated, it is assumed that all of the Level-0 data shall be processed to Levels-1A and -1B, and that both Levels-1A and -1B products shall be archived. **SOURCE:** Reference 20.

FNR163: There shall be separate MODIS-N and MODIS-T Level-1A products. There probably shall be different calibration requirements and algorithms for different spectral channels and for different higher level processing (e.g., for land, ocean, and atmospheric products). Therefore, there shall probably be several Level-1A products some of which are combinations of MODIS-T and MODIS-N channels. **SOURCE:** Reference 20.

FNR164: Level-1A data shall be Level-0 data which are reformatted reversibly, with Earth location, solar and instrument zenith angle, calibration data, and other ancillary and instrument engineering data appended. **SOURCE:** Reference 20.

FNR165: The inputs to the Level-1 processor shall include:

a. Level-0 data
b. Spacecraft ephemeris data and attitude data from backup systems
c. Other ancillary data (e.g., CIA world map)
SOURCE: Reference 19.

FNR166: The word size for the Level-1 data products is TBD.

FNR167: The data compression format on-board the POP-1 or on the ground is TBD.

FNR168: The Level-1A data product shall contain the Level-0 counts of the sensor and the ancillary and instrument engineering data.

FNR169: All algorithm identifiers and constants necessary to recover Level-0 data from Level-1A products shall be appended to the Level-1A data. **SOURCE:** Reference 5, p. A-7.

FNR170: The CDHF shall strip out embedded calibration information from MODIS Level-0 data for use in the data processing. **SOURCE:** Reference B. Markham.

3.4.2.2 *Process Level-1B*

FNR171: The CDHF shall process calibration scenes to Level-1B. **SOURCE:** Reference B. Markham.

FNR172: There shall be separate MODIS-N and MODIS-T Level-1B products and certain other standard Level-1B products which may consist of combinations of selected MODIS-N and MODIS-T channels. For example, there may be different calibration algorithms and, therefore, separate 1B products for land, ocean, and atmospheric processing. **SOURCE:** Reference 20.

FNR173: Level-1B data shall be Level-1A data to which the radiometric calibration algorithms have been applied, perhaps irreversibly, to produce values of the instrument measurements (e.g., radiances or irradiances), and to which, the Earth location, and zenith angle algorithms have been applied. **SOURCE:** Reference 20.

FNR174: The Level-1B data product shall be, to the greatest extent possible, identical in format to that of Level-1A; however, the radiometric calibration shall be applied to the sensor units, and Earth location computations shall be applied at the anchor points. **SOURCE:** Reference 20.

FNR175: The CDHF shall process all data at least to Level-1B. Processing beyond Level-1B shall be handled on a request basis. **SOURCE:** Reference 5, p. A-7.

3.4.2.3 *Process Level-2*

FNR176: The Level-2 processor shall receive Level-1B data and any ancillary data necessary for the Level-2 processing step.

FNR177: The Level-2 product shall contain geophysical parameters derived from the Level-1B data by the application of geophysical parameters derived from the Level-1B data by the application of geophysical parameter algorithms.

FNR178: The Level-2 data product format shall be similar to that of the 1B data (i.e., orbital swaths of geophysical parameter values plus appended information.

FNR179: A basic set of derived properties is to be routinely computed for all appropriate incoming data. Candidate items are:

1. Terrestrial Leaf Area Index
2. Ocean Chlorophyll Pigment
3. Terrestrial Surface Temperature
4. Sea Surface Temperature

5. Aerosol Optical Depth (over oceans)
6. Chlorophyll Fluorescence
7,8. Additional Terrestrial Vegetation Indices
9. Bioluminescence
10. Ocean Cyanobacteria Index
11. Terrestrial Aerosol
12-15. Atmospheric Properties
16. Oceanic Particulate Calcium Carbonate Concentration
17. Cloud Top Pressure
18. Outgoing Longwave Radiation
19. Longwave Cloud Radiative Forcing
20. Cloud Fraction
21. Precipitation
22. Ground Temperature
23. Atmospheric Humidity Profile
24. Atmospheric Ozone Profile

SOURCE: Reference 8 (Ch. VI), J. Susskind.

FNR180: The CDHF shall compile statistical information for each unit of Level-2 data processed. **SOURCE:** Reference 6, p. 6.

3.4.2.4 *Process Level-3*

FNR181: The Level-3 processor shall receive Levels-1 and -2 data and any ancillary data necessary for the Level-3 processing step. **SOURCE:** Reference 20.

FNR182: The Level-3 data product shall contain Earth-gridded geophysical parameter data including radiances, etc., from Level-1 averaged or composited in time and in space. **SOURCE:** Reference 20.

3.4.2.5 *Process Level-4*

FNR183: The Level-4 processor shall receive Levels-1, -2, and -3 data and any ancillary or correlative data necessary for the Level-4 processing step.

FNR184: The Level-4 product shall contain TBD analyses of the lower levels of MODIS data products.

3.4.3 Manage Processing and Handle Data

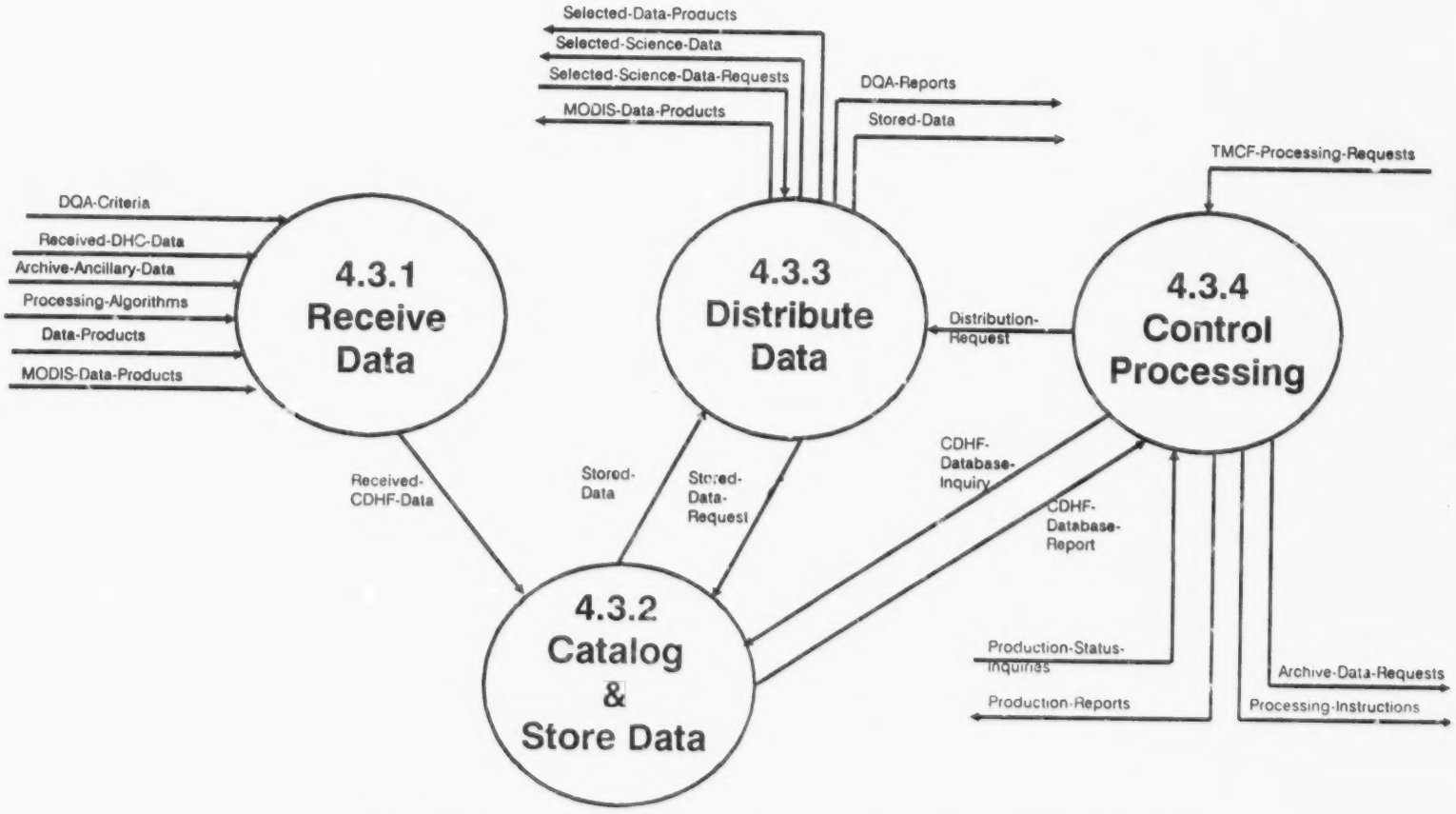
[See Data Flow Diagram 4.3: Manage Processing and Handle Data]

3.4.3.1 *Receive Data*

FNR185: The CDHF shall receive any archive data or processing algorithms necessary for Levels-1 through -4 processing. **SOURCE:** Reference 20.

FNR186: The CDHF shall acquire calibration coefficients and algorithms from the TMCF for use in the routine processing of Level-1A data to Level-1B. **SOURCE:** Reference J. Barker.

FNR187: The CDHF shall acquire special calibration coefficients and algorithms from the TMCF to test new approaches and to provide calibrated Level-1B data to the TMCF. **SOURCE:** Reference J. Barker.



CDHF DFD 4.3 Manage Processing & Handle Data

3.4.3.2 *Catalog and Store Data*

FNR188: The CDHF shall temporarily catalog and store data for routine processing, special processing, or reprocessing. **SOURCE:** Reference 3, p. 6-16; Reference 20.

FNR189: The CDHF shall compute parameters that are needed to support the indexing and cataloging of data. **SOURCE:** Reference 20.

3.4.3.3 *Distribute Data*

FNR190: The CDHF shall transmit MODIS products and DQA reports to the DADS for archiving. **SOURCE:** Reference 20.

FNR191: The CDHF shall provide subsets of standard, near-real-time, or specialized data to the TMCF upon request. **SOURCE:** Reference 18.

FNR191: The CDHF shall transmit selected subsets of MODIS science data to the ICC for monitoring of instrument performance. **SOURCE:** Reference 18.

FNR192: The CDHF shall support the archiving of processing algorithm identifiers and calibration constants. **SOURCE:** Reference 5, p. A-6 and Reference 7, p. 5-29.

3.4.3.4 *Control Processing*

FNR193: The CDHF shall perform job accounting functions daily and send reports to the IMC. **SOURCE:** Reference 7, p. 5-29.

FNR194: The CDHF shall accomodate new algorithms, access lower level data required for reprocessing, reprocess the data and update the archives with the resulting, improved data. **SOURCE:** Reference 6, page 7.

FNR195: The CDHF shall be capable of processing and reprocessing science data when requested to do so by the MODIS team. **SOURCE:** Reference 3, pp. 2-22, 5-30, 6-12 and Reference 5, p. A-6.

FNR196: Some near-real-time processing shall be required for operational purposes. **SOURCE:** Reference 6, page vii.

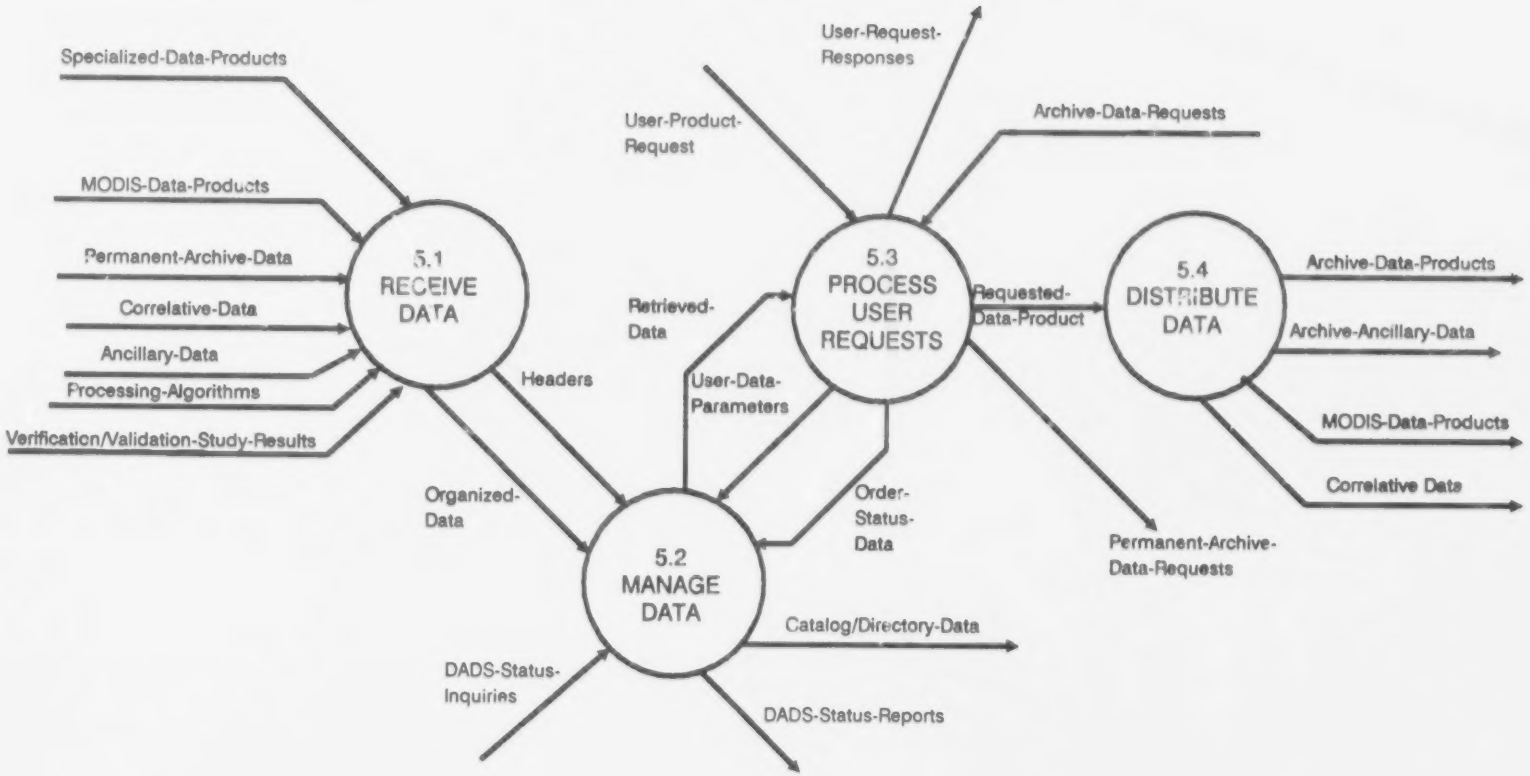
FNR197: The CDHF shall provide near-real-time processing in support of field experiments, geophysical event monitoring, and scientific quick-look analysis. **SOURCE:** Reference 5, p. A-8 and Reference 6, p. 5.

FNR198: The CDHF shall support the generation of data quality assessments. **SOURCE:** Reference 6, pp. 6 and 9.

FNR199: The CDHF shall provide interactive image processing and display to users requiring real-time or quick-look information. **SOURCE:** Reference 5, p. A-6.

3.5 DATA ARCHIVE AND DISTRIBUTION SYSTEM (DADS)

[See Data Flow Diagram 5.0: DADS Functional Data Flows]



DFD 5.0 DADS Functional Data Flows

3.5.1 Receive Data

[See Data Flow Diagram 5.1: Receive Data]

3.5.1.1 *Ingest Data*

FNR200: All sources of calibration information, procedures, and results must be identified and placed in the archival documentation. **SOURCE:** Reference 6, req #88.

FNR201: The DADS shall be able to ingest data sets as they become available, including in-situ data sets. This includes large data sets of the 1990's. **SOURCE:** Reference 5 (Req. No. 0101).

FNR202: Self-documenting software shall be required to create directory entries for newly acquired data. **SOURCE:** Reference 6, p. 46.

FNR203: Data from both optical components (MODIS-N and MODIS-T) shall be considered as a single data set. **SOURCE:** Reference 8, page vi.

FNR204: The DADS shall accept data from the TMCF for archive. **SOURCE:** Reference 3.

FNR205: The DADS shall receive specialized products, correlative data, and algorithms from the TMCF. **SOURCE:** Reference 3, pp. 2-23.

FNR206: The DADS shall accept MODIS data from the CDHF for archive. **SOURCE:** Reference 3.

FNR207: The DADS shall receive MODIS reprocessed data from the CDHF. **SOURCE:** Reference 5, pp. A-6.

FNR208: The DADS shall provide access to archive data from other platforms, other remote sensors, and from in-situ sensors for processing and validation of data sets. **SOURCE:** Reference 5 (Req. No. 0057 and 0030).

FNR209: The DADS shall provide for access to non-Eos data and model sources including: (1) directory of catalogs, (2) information on specific catalog access, (3) place data orders, (4) direct access, (5) direct order, and (6) real-time access. **SOURCE:** Reference 5 (Req. No. 0007).

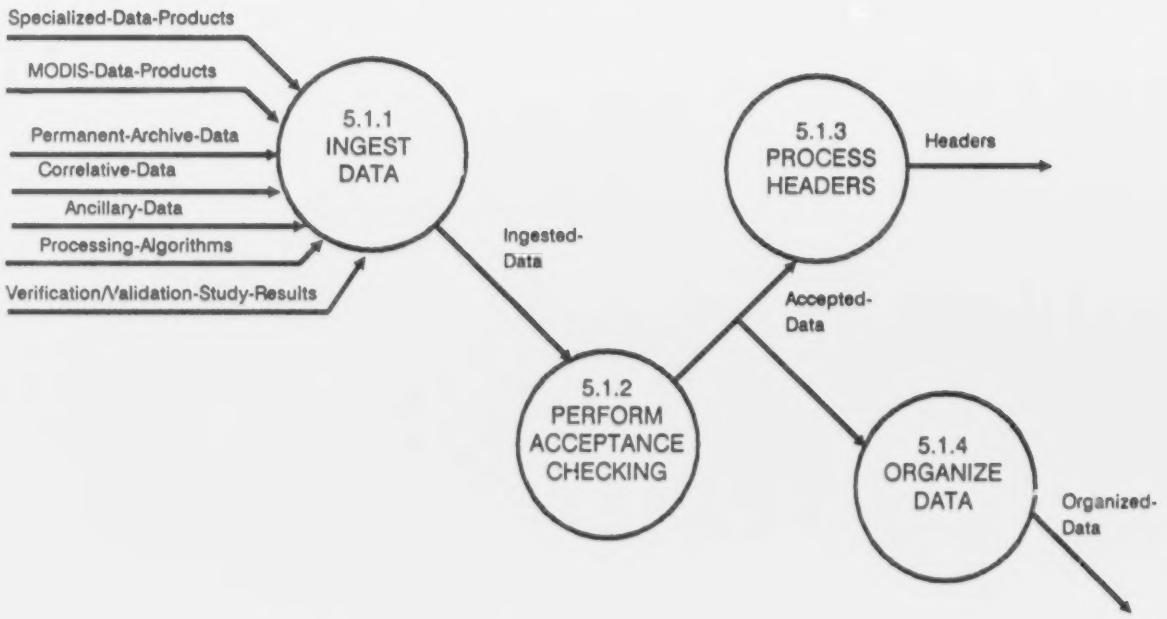
FNR210: The DADS shall accept correlative and ground truth data from other sources. **SOURCE:** Reference 5 (Req no 248).

3.5.1.2 *Perform Acceptance Checking*

FNR211: The DADS shall provide acceptance checking of all data ingested. **SOURCE:** Reference 6, p. 46.

3.5.1.3 *Process Headers*

FNR212: For each unit of processed data, a catalog record shall be generated, and shall include record start and stop times, and accountability of information to be maintained in catalogs. **SOURCE:** Reference 9, p. 3-10.



DFD 5.1 Receive Data

FNR213: Management software shall determine the source and contents of data sets, record what processing has been performed, where the data are stored, and form a cross reference list of data coverage, time, etc. This software shall prepare a catalog entry containing this information. Acquisition of non-Eos data sets for Eos purposes requires processing of these data to allow equivalent catalog entries to be made. **SOURCE:** Reference 6, page 25.

3.5.1.4 *Organize Data*

FNR214: The DADS shall archive by grouping of products (e.g., science regional and global). **SOURCE:** Reference 8, pp. 44 and 46.

FNR215: Although the data processing facility is responsible for seeing that all required data cataloging parameters are processed, the actual execution of a data classification scheme (parameter limits, etc.) is the responsibility of the DADS. The data discriminants available to the user shall include the algorithm identification appended during the high level processing. **SOURCE:** Reference 2 (Ch. VI)

FNR216: In the DADS, data shall be arranged into stable, predictable units to allow for automated cataloging, and easy user access to large data volumes. **SOURCE:** Reference 5 (Req. No. 0290).

3.5.2 **Manage Data**

[See Data Flow Diagram 5.2: Manage Data]

3.5.2.1 *Store Data*

FNR217: The DADS shall support an archive storage volume of TBD.
SOURCE: Reference 5 (Reqs 318-328).

FNR218: The DADS shall store Level-1 through Level-4 processed data and Level-0 data for which there is no Level-1 product reversible to Level-0. **SOURCE:** Reference 3, pp. 6-13.

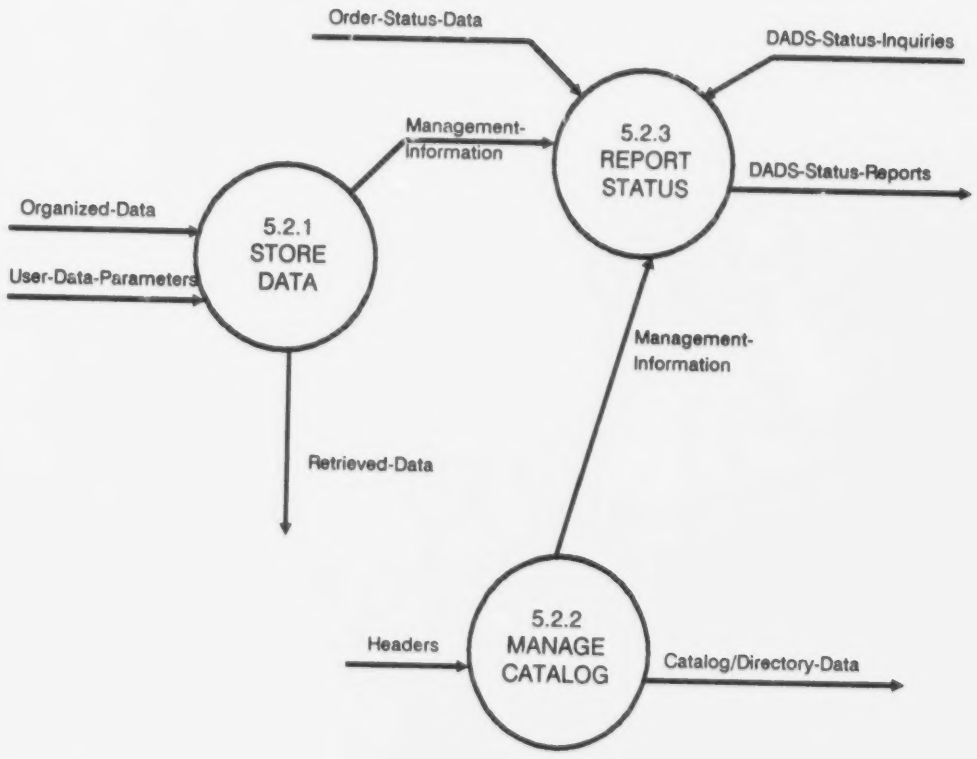
FNR219: The DADS shall store investigator-generated data products. **SOURCE:** Reference 3, pp. 5-36.

FNR220: The DADS facility shall temporarily store processed data sets for limited periods of time. **SOURCE:** Reference 3, p. 5-17, 5-33, and 5-34.

FNR221: The DADS archive shall provide browse file archives composed of reduced resolution data sets processed at least to Level-2, having regional or global coverage, and providing rapid interactive responses. **SOURCE:** Reference 5 (Req. No. 0328).

FNR222: The DADS shall store the following types of data: MODIS Data Products, Ancillary Data, Correlative Data, Specialized Data, Algorithms, Documentation, and Browse Data. **SOURCE:** Reference 3, pp. 5-17.

FNR223: The DADS shall include documentation of calibration procedures and results, including approximations and uncertainties. Calibration standards shall be trackable to the National Bureau of Standards. **SOURCE:** Reference 5 (Req. No. 0209) and Reference 6, p. 47.



DFD 5.2 Manage Data

FNR224: The DADS shall maintain an archive of calibration constants applied to the data. This archive shall be correlated with other data to enable reprocessing of old data using the same calibrations applied originally. **SOURCE**: Reference 5 (Req. No. 009).

FNR225: The DADS shall support on-line storage of data. **SOURCE**: Reference 3, pp. 6-13.

FNR226: Data attributes (e.g., cloud type and cover, vegetation type and cover, snow cover, data quality) should be appended to an inventory record within the browse files. **SOURCE:** Reference 6, p. 47.

FNR227: Attribute files should be expandable, enabling researcher-identified attributes to be added subsequently. **SOURCE:** Reference 6, p. 47.

FNR228: The archives shall provide an on-line bibliography containing references to all published and unpublished literature delivered from the project and shall allow users attribute searches. **SOURCE**: Reference 5 (Req. No. 0239).

FNR229: The archive shall provide off-line support of data subset selection by media volume only. **SOURCE**: Reference 5 (Req. No. 0263).

FNR230: The DADS shall archive software used to process reduced volume data sets. **SOURCE**: Reference 7, p. 5-30.

FNR231: The DADS shall provide product archiving of processed data to a permanent archive. **SOURCE**: Reference 3, p. 5-36.

FNR232: The DADS shall purge data in temporary storage after the data have been placed in permanent archive. **SOURCE**: FNR188 and FNR189, and Reference 5 (Req. 0304).

FNR233: The routine Level-3 products shall be archived permanently. **SOURCE:** Reference 8, page 44.

FNR234: Level-1B data, together with the cloud and land/ocean masks, shall be archived permanently. **SOURCE:** Reference 8, page 44.

FNR235: The DADS shall maintain documentation that describes the data processing procedures. **SOURCE:** Reference 3

FNR236: The DADS shall maintain a history of the calibration of the instruments used in the routine data processing, as supplied by the TMCF. Separate histories of each of the monitored instrument parameters shall be maintained. Each history can itself be considered as an auxiliary data product, such as:

a. Gains and offsets with uncertainties
b. Linearity checks
c. Polarization sensitivity studies
d. Spectral band to spectral band radiometric accuracy
e. Electronics calibration
f. On-board radiometric source output

SOURCE: Reference 3, 5 (req.no. 0209)

FNR237: If more than one calibration history exists (e.g., if the data are reprocessed), then all calibration histories shall be archived by the DADS along with information about how it was used in the data processing. **SOURCE:** Reference 5 (req. no. 009); J. Barker.

FNR238: The DADS shall maintain results of the prelaunch testing and calibration including raw data and processed results. **SOURCE:** Reference 5 (req. No. 0209); B. Markham.

3.5.2.2 *Manage Catalog*

FNR239: Browse files should be visually searchable via attributes and by expert system. **SOURCE:** Reference 6, p. 47.

FNR240: The DADS shall provide a directory of information showing location, ownership, data type, data processing level, version, parameter, time, or any combination of these. **SOURCE:** Reference 6, p. 46.

FNR241: The DADS shall provide a catalog of information showing project, platform, instrument, data processing level, version, parameter, time, geographic location, or any combination of the above. **SOURCE:** Reference 6, p. 46.

FNR242: The DADS archives directory shall include information about earth sciences data considered relevant by EOS-sponsored researchers, including an inventory of relevant documents concerning the data and archives. **SOURCE:** Reference 5 (Req. No. 0330).

FNR243: The DADS shall maintain and update the archive catalog and directory. **SOURCES:** Reference 6, pp. 46 and 47 and Reference 7, p. 5-23.

FNR244: On-line browse capabilities may not be possible for many users; this shall necessitate publication of an image browse catalog. **SOURCE:** Reference 6, p. 47.

FNR245: The MODIS data catalogs and directories shall accommodate data changes due to sorting, editing or labeling analysis, due to production of associated data, either inferred or correlated. **SOURCE:** Reference 5 (Req. No. 0243).

FNR246: The directory shall include information about supporting catalog access. **SOURCE:** Reference 6, p. 46.

FNR247: The directory and catalog shall be electronically available. **SOURCE:** Reference 6, p. 46.

FNR248: The DADS shall periodically update the IMC catalog and directories. **SOURCE:** Reference 3, pp. 2-23 and 25.

FNR249: The DADS shall maintain a variety of catalogs and directories on-line to accommodate ordering by date and time; instrument channel, resolution, and operating modes; environmental parameters; geophysical location; feature detection; data location; etc. **SOURCE:** Reference 3, p. 2-27.

FNR250: The data catalog shall be accessible by project, platform, instrument, data processing level, versions, parameter, time, geographic location, or any combination of the above. **SOURCE:** Reference 6, page 46.

FNR251: All processing software shall be preserved and documented, along with a report of design and testing rationale used by the software creator. This requirement also applies to

processing software used to locate the observations and calculate observational geometry parameters. **SOURCE:** Reference 6, page 12.

FNR252: The multi-tiered network shall serve multiple uses ranging from simple catalog searches to distribution of the low-level satellite data for further processing. **SOURCE:** Reference 8, page 44.

FNR253: Data quality and catalog software shall be able to detect and record instrumentation changes. **SOURCE:** Reference 6, page 25.

3.5.2.3 *Report Status*

FNR254: The DADS shall periodically provide performance summary archives to include data accounting summaries and other non-spatial data sets having no geographical dependence. **SOURCE:** Reference 5 (Req. No. 0217).

FNR255: The DADS shall be automated to handle large data volumes effectively; recordkeeping and generation of summary reports should be added functions. Management software shall determine the source and contents of data sets, record what processing has been performed, where the data are stored, and form a cross reference list. The software shall prepare catalog entries. Any use of the data should also be monitored and recorded. **SOURCE:** Reference 9, p. 88-89.

FNR256: The DADS shall generate status reports (i.e., define status of the system, data volume handled, data request backlog, etc.). **SOURCE:** Reference 7, p. 5-27.

FNR257: The DADS shall perform job accounting functions daily and send reports to the IMC. **SOURCE:** Reference 7, p. 5-29.

FNR258: The DADS shall provide accounting information for each product order such as catalog usage, archival loading, and resource usage. **SOURCE** derived from Reference 5, p. 6-49 and Reference 7, p. 5-29.

FNR259: The DADS shall monitor performance of the archive system. **SOURCE:** Reference 7, p. 5-26.

3.5.3 Process User Requests

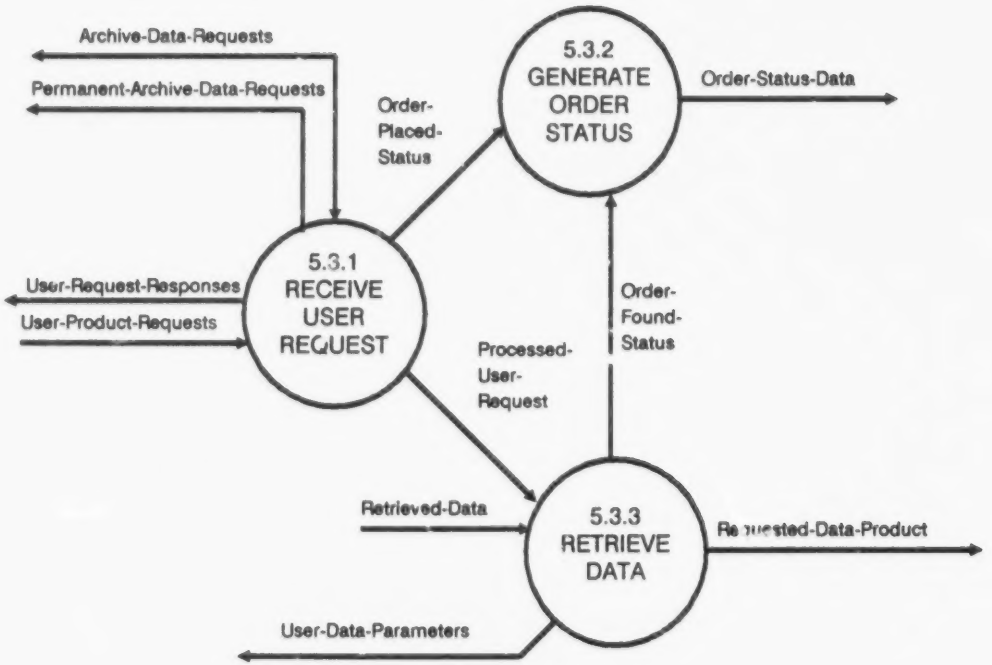
[See Data Flow Diagram 5.3: Process User Requests]

3.5.3.1 *Receive User Request*

FNR260: The DADS shall provide users with the ability to order through the catalog subsystem. Orders may be handled manually. **SOURCE:** Reference 5 (Req. No. 0264).

FNR261: The DADS shall verify and convert product queries to orders. **SOURCE:** Reference 6, p. 46.

FNR262: The DADS shall provide users with browse capability of reduced volume data sets. These data sets shall be made available at several processing levels.
SOURCE: Reference 3



DFD 5.3 Process User Requests

FNR263: The DADS shall provide interactive image processing and display to users requiring real-time or quick-look information. Interactive image browse capability and interactive data processing shall also be provided. **SOURCE:** Reference 3

FNR264: The DADS shall support exchange of heterogeneous data sets, not only among the different elements of EosDIS, but also with other systems both internal and external to NASA. **SOURCE:** Reference 6, page 18.

FNR265: The DADS shall provide for interactive, electronic catalog and ordering functions with a minimum 9600 bps dial-up capability. **SOURCE:** Reference 5 (Req No 37).

FNR266: The DADS shall support query of referenced data bases by other Eos elements. **SOURCE:** Reference 5 (Req. No. 0261).

FNR267: The DADS shall be capable of retrieving and sending data sets to the CDHF for reprocessing in response to a data request. **SOURCE:** Reference 5, p. A6.

3.5.3.2 *Generate Order Status*

FNR268: The DADS shall generate status reports of the retrieval process for requested data and make these available to the requestor and/or the IMC. **SOURCE:** Reference 7, p. 5-26 and 29.

3.5.3.3 *Retrieve Data*

FNR269: The DADS shall be capable of locating one or more requested data sets or products by searching through its data structure of the data archive based on data parameters or product attributes specified in the request. **SOURCE:** Reference 12, p. 34.

FNR270: Browse files should be accessible by time, geographic, location, or any combination of these factors. **SOURCE:** Reference 6, p. 47.

FNR271: The DADS shall follow a standard format structure for data interchange. **SOURCE:** Reference 6, page 14.

3.5.4 Distribute Data

[See Data Flow Diagram 5.4: Distribute Data]

FNR272: The DADS shall provide for a spectrum of electronic delivery rates. **SOURCE:** Reference 6, p. 46.

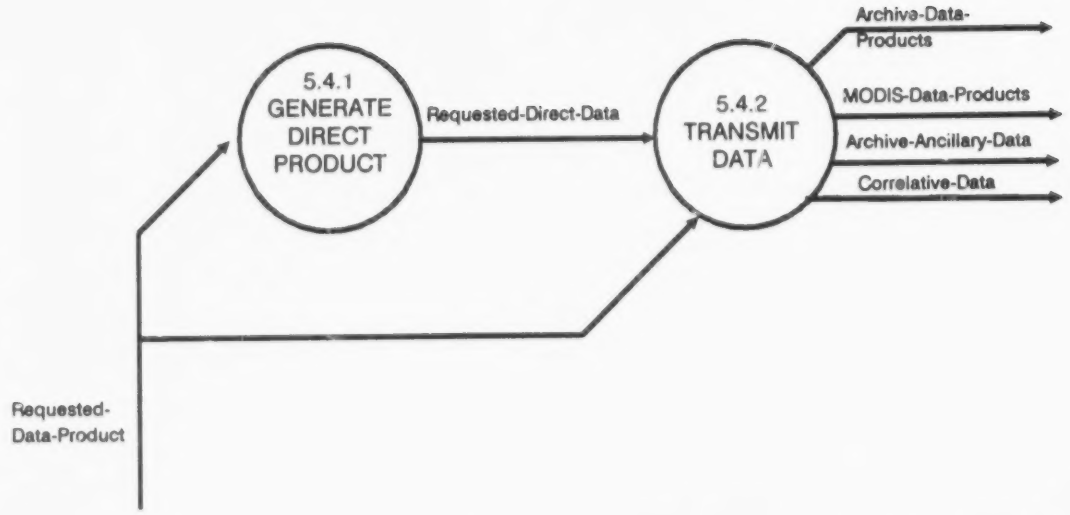
FNR273: High-density storage media (e.g., optical disk or tape) shall be used to distribute data in lieu of communication links. **SOURCE:** Reference 3, p. 5-39.

3.5.4.1 *Generate Direct Product*

FNR274: High-density storage media (e.g., optical disk or tape) shall be used to distribute data in lieu of communication links. **SOURCE:** Reference 3, p. 5-39.

3.5.4.2 *Transmit Data*

FNR275: The DADS shall distribute data sets to users on appropriate media or transmit data over a communications line. **SOURCE:** Reference 5 (Req. No. 0271).



DFD 5.4 Distribute Data

FNR276: The DADS shall provide for a spectrum of electronic delivery rates. **SOURCE:** Reference 6, p. 46.

3.6 ON-BOARD PROCESSING

FNR277: To facilitate the analysis of real-time data, the MODIS data shall be packetized on board the platform by channel, detector, and scan line (1,292 pixels by 12 bits corresponds to 1,938 8-bit bytes). **SOURCE:** Reference 19.

FNR278: The MODIS data shall be buffered on board the platform for a complete scan to permit the required packetization of the data. **SOURCE:** Reference 19.

FNR279: On-board storage of 8 megabytes for MODIS-T (64 x 64 x 1,294 x 12/8) and 1.5 megabytes for MODIS-N (752 x 1,294 x 12/8; 752 = 30 x 8 + 8 x 32 + 2 x 128) shall be required to provide on-board buffering capabilities. **SOURCE:** Reference 19.

FNR280: Employ standards that require each data source (e.g., engineering subsystem, instrument) to encapsulate its data messages into source packets having globally interpretable labels that define the source and destination, class of service, priorities and delivery conditions, and provide the information required for verification, validation, and accounting of data within the packet. **SOURCE:** Reference 6, page 16.

FNR281: The on-board processing system of MODIS shall have information about the current and future positions of the spacecraft, the attitude of the spacecraft and the sensors, sun position, and surface illumination angles. Reference 8, page 43.

FNR282: The on-board processing system of MODIS shall store a world map that identifies some essential characteristics of the earth in regions varying in size from approximately 30 km x 30 km to 300 km x 300 km, depending on their location. Reference 8, page 43.

4. PERFORMANCE REQUIREMENTS

Here we consider the set of performance requirements that have been compiled for the MODIS data system. These performance requirements follow as a natural consequence of the functional requirements. They specify the requirements for response times, throughput capabilities, storage capacities, and other parameters that relate to the performance of the system. For the MODIS data system, they apply to the entire MODIS data system, specific elements of the data system (the CDHF, DADS, ICC, TMCF, and IST), and processes or functions within each element. The performance requirements are dependent on both the MODIS Science and Instrument Team requirements and EosDIS standards. Examples of quantitative performance requirements include overall system response times, communications link and processor throughput capabilities, and data storage capacities. Such performance measures can be specified both for the overall system operating as a whole and for the individual components that make up the system. Performance requirements are determined by the MODIS Science and Instrument Team members and by the various EosDIS organizations and committees that set standards and goals for all data systems supporting Eos instruments (including MODIS). Ultimately, many of the specific performance requirements for individual MICACS system components shall be derived by the MICACS Study Team from more general requirements on overall system performance stated by the MODIS Science and Instrument Teams.

In addition to qualitative statements describing the general structure and design features of the MIDACS, a complete specification of that system includes specific quantitative measures of the required performance that the overall system and its individual components must achieve. While it is still very early in the Phase B study and many qualitative features of the system

and its components are still being defined, some quantitative measures of required performance have been given, and these early statements can be used as the basis of a very preliminary set of original and derived MIDACS performance requirements. A complete statement of requirements shall not be available until the completion of Phase B studies; indeed, it is the goal of the MIDACS Phase B study to produce a system specification that defines all aspects of required system performance.

The following two figures illustrate in a very general sense the relationship between various aspects of the MODIS data system and the EosDIS. Figure 9 presents the interactions between the IST, the ICC, and the EMOC. We see observation requests originating from the IST being passed to the ICC. From the ICC, schedule data is then forwarded to the EMOC, which must then respond with the command confirmation. The ICC then provides a response to the IST. In Figure 10, the primary downlink data flows between the relevant EosDIS, MODIS data system, and the science community are portrayed; specifically, the DHC, MODIS ICC, CDHF, DADS, and the data users. These relationships become important (in addition to the functional requirements for the data system elements) in developing a complete set of, and logical flow between, the performance requirements. Appendices D and E extend the preliminary view of the various data flows that occur throughout the system; the emphasis here is on high rate data flows that require special consideration in the design of the MIDACS. Appendix E contains a very preliminary computation of required processor capability based on the data rates projected in Appendix D and estimated computational path lengths for MIDACS data products, as well as the data storage capability required to support the system given the earlier defined data rates. Since many specifics are yet to be defined, all numbers in this report are initial estimates based on preliminary and incomplete information. Revisions shall undoubtedly occur as system needs are more realistically and specifically defined.

At the present time, we have accumulated on the order of 280 functional requirements for the MODIS data system and its elements. There are, at present, only about 70 performance requirements for the system. Many of the performance requirements are specified only in a general sense, with the precise details of the performance requirements left "TBD." Moreover, the individual requirements, compiled from different sources, are sometimes in conflict, or overlap, with each other. A continued refinement of these performance requirements shall occur throughout this Phase-B data system study.

4.1 INSTRUMENT SUPPORT TERMINAL (IST)

The IST is responsible for two basic functions: (1) science planning and coordination and (2) instrument performance evaluation.

PRR1: There shall be at least one IST to support MODIS.

4.1.1 Science Planning and Coordination

4.1.1.1 *Planning Data*

4.1.1.2 *Observation Plan Coordination*

4.1.1.3 *Observation Requests*

4.1.2 Instrument Performance Evaluation

4.1.2.1 *Instrument State-of-Health Analysis*

4.1.2.2 *Instrument Model Parameters Maintenance*

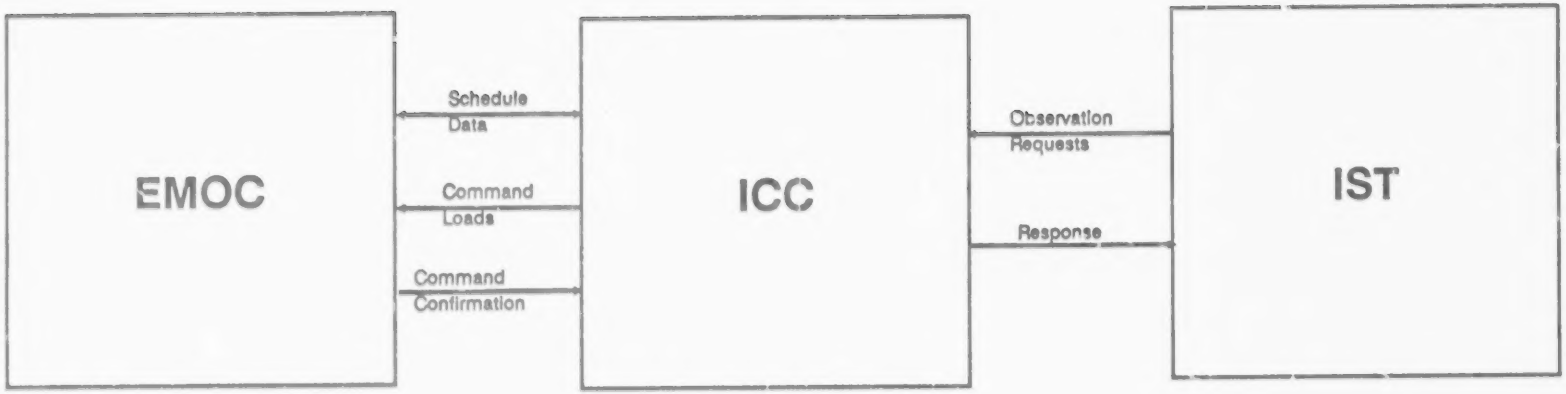


Figure 9. Primary Command Data Flows

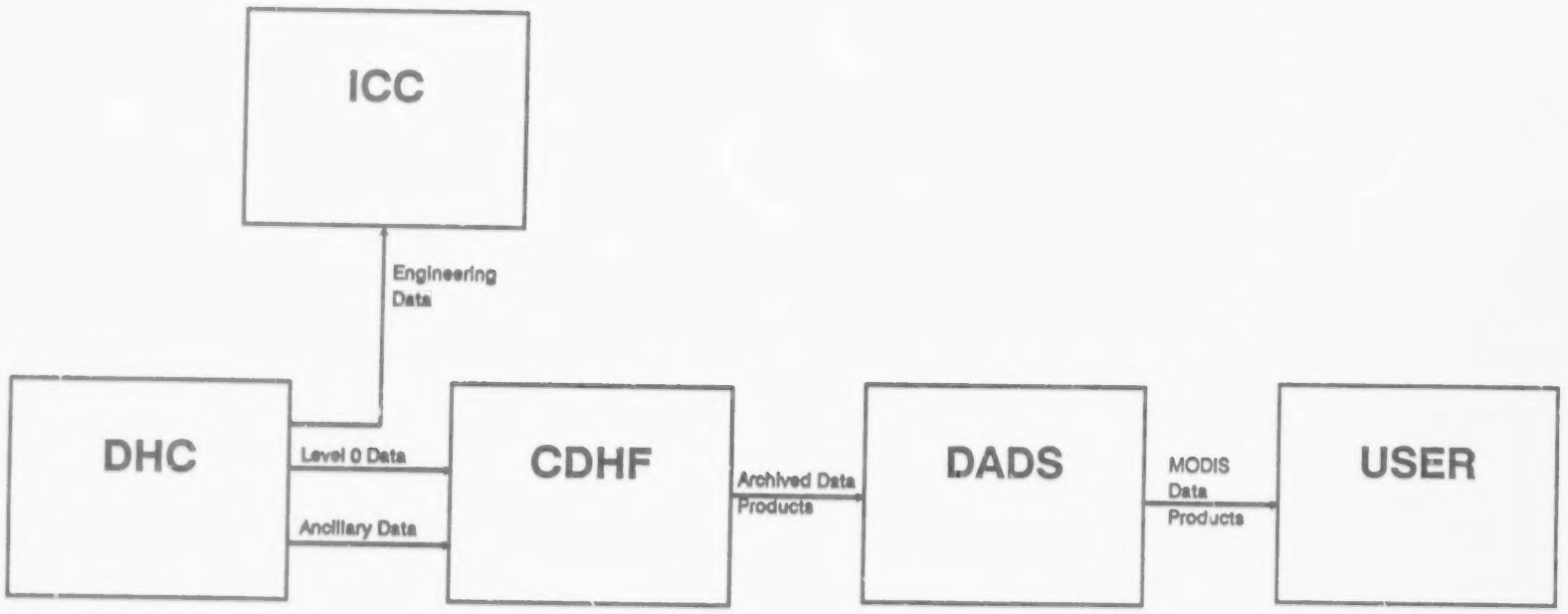


Figure 10. Primary Downlink Data Flows

4.2 INSTRUMENT CONTROL CENTER (ICC)

The ICC is responsible for two basic functions: (1) operations planning and scheduling and (2) instrument control and monitoring.

PRR2: There shall be an ICC dedicated to MODIS.

4.2.1 Operations Planning and Scheduling

4.2.1.1 *Observation Requests*

PRR3: The ICC shall provide the IST confirmation of the correctness and feasibility of observation requests within TBD of the receipt of the request. **SOURCE:** Reference 12, p. 51.

PRR4: The ICC shall respond to a request for near-real-time data products within the time period of one orbit. **SOURCE:** Reference 5, Req. 32; Reference 6, p. 5.

4.2.1.2 *Instrument Time-Line Generation*

4.2.1.3 *Resource Requirement Generation*

PRR5: The ICC shall disseminate to the EMOC within TBD minutes the detailed schedule for the MODIS instrument after receipt of the EMOC resource envelope. **SOURCE:** Reference 12, p. 51.

4.2.1.4 *Schedule Request Generation*

PRR6: The ICC shall, upon receipt of a reschedule request from EMOC, generate an updated command load associated with a MODIS instrument schedule within TBD minutes. **SOURCE:** Reference 12, p. 51.

4.2.1.5 *Command Sequence Generation*

PRR7: The ICC shall generate target-of-opportunity commands in near real-time. **SOURCE:** Reference 3, p. 52.

PRR8: The ICC shall forward unconditionally allowable commands in real-time. **SOURCE:** Reference 7, p. 5-15.

PRR9: For commands, loop delays shall not be more than 10 seconds between command delivery and received response. **SOURCE:** Reference 2 (ICC Facility).

PRR10: In some cases, instrument command decisions will have to be made within the time period of one orbit. **SOURCE:** Reference 6, p. 45.

PRR11: The ICC shall automatically generate, or select from sets of predefined command sequences, a safing command sequence for transmission to the EMOC within TBD seconds. **SOURCE:** Reference 12, p. 51.

PRR12: The ICC shall provide a new command sequence within TBD hours in response to a schedule change directed by the MODIS Instrument Team leader. **SOURCE:** Reference 2 (ICC Facility).

4.2.1.6 *Reference Monitoring Profile Generation*

4.2.1.7 *Mission Planning Information*

4.2.2 Instrument Control and Monitor

4.2.2.1 *Instrument State-of-Health Monitoring*

PRR13: The ICC shall assess the quality of science data in near real-time for selected samples of data. **SOURCE:** Reference 7, p. 5-16.

4.2.2.2 *Engineering Trend Analysis*

4.2.2.3 *Command Processing*

PRR14: The ICC shall monitor instrument status and confirm responses to uplink commands in near real-time. 95% of the real- time data broadcast by the satellite should be received, preprocessed, and displayed within 60 seconds from the transmission. **SOURCE:** Reference 6, p. 4.

4.2.2.4 *Displays and Status Reports*

PRR15: Raw instrument data from the DHC shall be immediately processed to provide a select set of graphic data products that are useful in assessing the instrument function. The exact data presentations to be supported are TBD. **SOURCE:** Reference 12, p. 51.

PRR16: An alarm shall be generated by the ICC within TBD seconds, upon receipt of engineering data and other input data for each scene, to inform the IST and EMOC whenever an operation parameter exceeds the allowable range. **SOURCE:** Reference 12, p. 51.

PRR17: The ICC shall generate an alarm, upon receipt of status information about EMOC, PSC, TDRSS, or other instruments from the EMOC, indicating anomaly condition which may affect the operation of the MODIS instrument within TBD seconds. This alarm shall be forwarded to the IST.

PRR18: The ICC shall, upon request from the IST or EMOC, generate an instrument SOH report based on engineering data covering that period within TBD minutes. **SOURCE:** Reference 12, p. 51.

PRR19: The ICC shall, upon request from the IST, generate an instrument operational history report using data quality assessments (DQA), engineering data, detailed schedule information, and commands, within TBD minutes. **SOURCE:** Reference 12, p. 51.

4.3 TEAM MEMBER COMPUTING FACILITY (TMCF)

The TMCF is responsible for three basic functions: (1) develop and maintain science/calibration algorithms, (2) validate/verify data, and (3) plan and coordinate.

4.3.1 Develop and Maintain Science/Calibration Algorithms

4.3.1.1 *Develop Algorithms*

4.3.1.2 *Test and Modify Algorithms*

PRR20: The TMCF shall verify that the pointing accuracy of the MODIS instrument data sets is within the required accuracy of TBD kilometers.

4.3.1.3 *Implement and Certify Algorithms*

PRR21: The TMCF shall provide the CDHF with calibration coefficients in sufficient time such that Level-1B data processing can occur on schedule.

4.3.2 Verify/Validate Data

4.3.2.1 *Receive and Catalog Data Inputs*

4.3.2.2 *Produce Special Data Products*

4.3.2.3 *Perform Statistical Studies and Modeling*

4.3.3 Plan and Coordinate

4.3.3.1 *Receive Requests and Catalog*

4.3.3.2 *Sort and Set Priority of Requests*

4.3.3.3 *Develop Science Management Plan*

4.3.3.4 *Send Requests*

4.4 CENTRAL DATA HANDLING FACILITY (CDHF)

The CDHF is responsible for three basic functions: (1) receive DHC data, (2) produce data products, and (3) control process and handle data.

4.4.1 Receive DHC Data

4.4.1.1 *Ingest Data*

4.4.1.2 *Perform Acceptance Checking*

4.4.1.3 *Reformat Data and Append Header*

4.4.2 Produce Data Products

PRR22: All near-real-time data processing shall be completed within three to eight hours at all levels (Levels-1A to -3). The precise timeliness requirements will depend on the specific data requirements of the field experiment. **SOURCE:** Reference 19.

PRR23: The data system shall be sized to support 15 simultaneous field experiments each for MODIS-N and MODIS-T: five for atmospheric sciences, five for oceanography, and five for land-sciences (a total of 30). **SOURCE:** Reference 19.

PRR24: For each field experiment supported, a set of scenes shall be generated. A scene is defined as having the dimensions of a full cross-track scan width (i.e., 1294 pixels or about 2,000 km) by 2,000 kilometers (i.e., about 2,048 one-kilometer detector swaths or five

minutes of data). A set of scenes shall include the calibrated and Earth-located (Level-1B) radiances for 15 to 20 spectral channels, 25 Level-2 parameters, and TBD Level-3 products. **SOURCE:** Reference 19.

PRR25: The CDHF shall be sized to be capable of simultaneously supporting processing, reprocessing, backlog processing, near-real-time processing, browse processing, and normal system maintenance.

PRR26: The CDHF shall be sized such that it will not be utilized in excess of 70% of the system's processing capacity. **SOURCE:** Reference 3.

PRR27: The Level-1 processor shall have the capacity to process 24 hours of playback data within 8 hours after receipt of the data. **SOURCE:** Reference 3, p. 6-25.

PRR28: The Levels-2, -3, and -4 processors shall each have the capacity to process 24 hours of data within 12 hours of the next 24-hour period.

PRR29: The CDHF shall routinely process standard products.

4.4.2.1 *Process Level-1A*

PRR30: The amount of Level-0 data to be processed to Level-1A is equal to TBD times the raw MODIS instrument data.

PRR31: All Level-0 data sets received within a 24-hour period shall be completely Level-1A processed within 12 hours.

PRR32: Results of Level-1A processing shall be available to authorized investigators within 48 hours of the original observation.

4.4.2.2 *Process Level-1B*

PRR33: The amount of Level-1A data to be processed to Level-1B is equal to TBD times the raw MODIS instrument data.

PRR34: All Level-1A data sets received within a 24-hour period shall be completely Level-1B processed within 12 hours.

4.4.2.3 *Process Level-2*

PRR35: The amount of Level-1B data to be processed to Level-2 is equal to TBD times the raw MODIS instrument data.

PRR36: All Level-1B data sets received within a 24-hour period shall be completely Level-2 processed within 8 hours.

4.4.2.4 *Process Level-3*

PRR37: The amount of Level-2 data to be processed to Level-3 is equal to TBD times the raw MODIS instrument data.

PRR38: All Level-2 data sets received within a 24-hour period shall be completely Level-3 processed within 8 hours.

4.4.2.5 *Process Level-4*

PRR39: The amount of Level-3 data to be processed to Level-4 is equal to TBD times the raw MODIS instrument data.

4.4.3 Control Processing and Handle Data

4.4.3.1 *Receive Data*

4.4.3.2 *Catalog and Store Data*

PRR40: The CDHF shall provide a storage system utilizing fast access storage for on-line working storage and for protection against data loss.

PRR41: The CDHF shall be capable of storing data at the volume of TBD Gbytes/day in its data store to facilitate retention of data, algorithms, and products.

4.4.3.3 *Distribute Data*

4.4.3.4 *Control Processing*

PRR42: Investigator processing requests for near-real-time data should be completed within the time frame of one orbit. **SOURCE:** Reference 6, p. 10.

PRR43: All data shall be reprocessed a maximum of two times during the 20-year mission. [Clearly, this EosDIS assumption is questionable. Past experience indicates that data sets may be reprocessed more than twice; for example, as improved calibration algorithms and geophysical parameter retrieval algorithms become available.]

4.5 DATA ARCHIVE AND DISTRIBUTION SYSTEM (DADS)

The DADS is responsible for four basic functions: (1) receive data, (2) manage data, (3) process user requests, and (4) distribute data.

4.5.1 Receive Data

4.5.1.1 *Ingest Data*

4.5.1.2 *Perform Acceptance Checking*

4.5.1.3 *Process Headers*

4.5.1.4 *Organize Data*

PRR44: The DADS catalog will be updated with the information provided by the data set producing organization as soon as practical (i.e., daily). The catalog entry associated with each archive data set shall be inserted into the catalog as the data set is inserted into the archive. **SOURCE:** Reference 13, p. 4-25.

4.5.2 Manage Data

4.5.2.1 *Store Data*

PRR45: The DADS archive shall maintain data on media that provide long lifetimes, rapid and random access, and economical storage. **SOURCE:** Reference 5, Req. #0270.

PRR46: The DADS shall provide a data storage system using slow access with buffering. **SOURCE:** Reference 3, p. 6-14.

PRR47: The DADS shall size base system for a user community of 1,000 to 10,000; 50 to 200 active at any time, ordering 5 to 10 tapes per month; 1 to 10 users ordering large volumes of data and handle up to 100 simultaneous users. **SOURCE:** Reference 5, Req. #0324.

PRR48: The DADS shall be capable of storing data at the volume of TBD Gbytes/day in its data store to facilitate retention of data and products. **SOURCE:** Reference 12, p. 54.

PRR49: The average and maximum total archive data retrieval volume for electronic distribution is estimated to be TBD GBytes.

4.5.2.2 *Manage Catalog*

PRR50: The number of catalog entries to be managed by the DADS is TBD.

4.5.2.3 *Report Status*

4.5.3 Process User Requests

4.5.3.1 *Receive User Requests*

PRR51: The estimated daily number of retrieval orders for electronic distribution is TBD.

PRR52: The DADS shall handle up to 100 simultaneous interactive catalog/browse/ordering system users. **SOURCE:** Reference 6, p. 47.

PRR53: The DADS shall provide for interactive, electronic catalog and ordering functions with a minimum 9600 bps dial-up capability. **SOURCE:** Reference 5, Req. #37.

PRR54: The amount of queries supported by the DADS is TBD. **SOURCE:** Reference 13, p. 4-29.

PRR55: The archive shall be accessible from remote terminals or workstations via a prompting menu or natural language interface, supplemented by a free-form command language for experienced users. **SOURCE:** Reference 5, Req. #0236.

4.5.3.2 *Generate Order Status*

4.5.3.3 *Retrieve Data*

PRR56: An interactive catalog system should provide a response to most search commands within 1 to 15 seconds. **SOURCE:** Reference 6, p. 11.

PRR57: Response time of the DADS to a user should be timely, and shall be limited by the search capability of the system. **SOURCE:** Reference 3, p. 2-27.

4.5.4 Distribute Data

PRR58: The DADS shall be capable of satisfying the need for data by multiple users, each user possibly requiring a different time line and path. **SOURCE:** Reference 5, Req. #908.

PRR59: The retrieval and transfer of catalog information shall be accomplished with a bit error rate of TBD. [10^{-12}?]

PRR60: Near-real-time processed data shall be required for operational purposes, and may be of value for interactive browse activities. **SOURCE:** Reference 6, p. vii.

PRR61: Browse files should be visually searchable via attributes (e.g., day, position, time, channel, parameter) and by an expert system. **SOURCE:** Reference 6, p. 47.

PRR62: On-line browse capabilities may not be possible for many users; this shall necessitate publication of an image browse catalog. **SOURCE:** Reference 6, p. 47.

PRR63: It is a goal that the DADS retrieve the first data set of the order and start the transmission of the data set for orders requesting on-line data within 40 seconds of receipt of the order for 50 percent of all orders and within 100 seconds for 90 percent of all orders. **SOURCE:** Reference 13, p. 4-19.

PRR64: The DADS shall be capable of retrieving the products, including associated ancillary data, for a scene ordered by the user and make them available for dissemination to the user or DDC in less than an hour upon receipt of the product order. **SOURCE:** Reference 12, p. 54.

PRR65: The DADS will retrieve the first data set of orders for off-line data within 30 minutes for 90 percent of all such orders.

4.5.4.1 *Generate Direct Product*

PRR66: The DADS shall be capable of responding to orders requesting archive data on tape, optical disk, or listings within three working days. The DADS shall receive and process these orders in terms of locating the requested data, producing them on the request medium, preparing them for mailing, and properly accounting for their production. **SOURCE:** Reference 13, p. 4-20.

4.5.4.2 *Transmit Data*

PRR67: The DADS will transmit electronic orders which do not require interactive servicing (e.g., data retrieved for recalibration) at convenient times. **SOURCE:** Reference 13, p. 4-20.

PRR68: The DADS shall be capable of providing a minimum requirement (or maximum response time) for all archive data orders placed electronically requiring interactive servicing and requesting on-line data (e.g., browse data). **SOURCE:** Reference 12, p. 54; Reference 13, p. 4-19.

4.6 ON-BOARD PROCESSING

PRR69: On-board compression of the MODIS instrument data shall be applied if necessary to insure that the maximum and mean data rates do not exceed TBD and TBD Mbps, respectively.

5. SYSTEM INTERFACE REQUIREMENTS

Each MIDACS element (IST, ICC, TMCF, CDHF, and DADS) is a logical entity that performs a particular subset of required MIDACS functions. The division of overall system function among modules dedicated to instrument control, data processing, data storage and retrieval, etc. presents a natural opportunity to select separate, specialized hardware components for each module. Each hardware unit can then be chosen to provide support specifically tailored to a corresponding software function. And distinct hardware components naturally allow the physical separation of MIDACS elements when remote access is needed. Therefore, the initial MIDACS design is being specified to allow the possibility that each MIDACS element will be a physically distinct entity.

If each MIDACS element is physically distinct, then the data interfaces shown in the overall MIDACS context diagram and the MIDACS element context diagrams are not just logical interfaces, but physical interfaces as well. The logical structure of the system and the general nature of interfaces is documented in the data flow diagrams and the corresponding data dictionary descriptions of the data flows. The interested reader is referred to the appropriate sections of this document where these documents are included. Beyond that, this section of the document contains two additional items pertaining to MIDACS interfaces: short statements of specific interface requirements extracted from earlier MIDACS documents (similar to the requirements listed elsewhere in this document) and interface tables listing each physical interface and giving qualitative descriptions of required data transmission capability for each interface. Section 5.1 contains a list of extracted interface requirements generally applicable to the entire data system. Section 5.2 (Internal Interfaces) and section 5.3 (External Interfaces) each begin with charts showing qualitative characteristics of the required interfaces. Each section then concludes with a list of extracted requirements applying specifically to that type of interface.

5.1 GENERAL REQUIREMENTS

SSR1: The TMCF shall supply the CDHF with the calibration and scientific algorithms as they are developed. These algorithms will be updated during the course of the mission as required. **SOURCE:** Reference derived from FNR85.

SSR2: The TMCF shall supply DADS with the calibration and scientific algorithms as they are developed and information on how they were used in the data processing. **SOURCE:** Reference derived from FNR85.

SSR3: The interface shall maximize opportunities for commonality within the system and ensure flexibility in the implementation of the interface. (Level I REQ# 1.2.3)

SSR4: The interface shall use standard, off-the-shelf hardware and software wherever possible to facilitate modernization during the system's lifetime. (Level I REQ# 1.2.4)

SSR5: The interface shall make maximum practicable use of standards for data structures and data transport defined for use within the Space Station Information System (SSIS), the International Standard Organization's open system concept, and the publications of the Consultative Committee for Space Data Systems (CCSDS). (Level I REQ# 1.2.5)

SSR6: The interface shall be designed to accommodate growth in instrument data rates and volumes. (Level I REQ# 2.1.1)

SSR7: The interface shall be technologically transparent. (Level I REQ# 2.1.2)

SSR8: The MIDACS shall provide a convenient and effective interface to the user and scientist which optimizes their access to data, information, and resources available for their use. (Level I REQ# 2.3.14)

5.2 INTERNAL INTERFACES

Table 1 lists four qualitative characteristics for each internal interface within the MIDACS. The first item listed is estimated data transfer rate, roughly characterized as low, moderate, or high. While the specific quantitative intervals to be associated with each designation can not be defined until more complete studies are completed, rough descriptions of each data-rate category can be given. Generally, low data rates are understood to include rates suitable for transmitting textual or other human-interpretable coordination materials with limited numerical or machine-readable content. High data rates are understood to be roughly within an order of magnitude of the MODIS instrument average data rates, perhaps greater than 1 Mbps or so. Moderate rates are between the extremes, data rates requiring machine interpretation for effective utilization, but not an appreciable fraction of the full MODIS instrument data rate.

The Frequency of Use parameter is characterized as either Occasional or Regular. Regular use is understood to mean that communications resource sharing could not be effectively employed and that only dedicated resources could be employed. Occasional use is obviously something less than Regular Use.

The data Timeliness Requirement is characterized as either Real-Time, Near-Real-Time, or Routine. Real-Time data is understood to be data that is needed essentially as it becomes available with only minimal storage delays in data transmission buffers. Near-Real-Time data is data that must be completely processed within 3 to 8 hours, so that some minimal transmission delay is acceptable, but definite time limits exist, and the entire processing routine must be completed within these time limits. For Routine Processing, data storage is allowed, and data can be queued to await processing. Routine processing is variously defined to be processing that must be completed within 24 or 48 hours.

Two data path length designations are defined: Local means essentially that data path requirements are not greater than building-to-building communications on a particular campus. All other communications are listed as Remote. Links that could be either Local or Remote have been listed as Local/Remote.

5.2.1 ICC - IST Interface

SSR9: The ICC shall send instrument monitoring informations and displays to the IST for further investigation of instrument anomalies. Reference 16 p. 5-17.

SSR10: The IST shall submit observation requests to the ICC. Reference 16, p.5- 17.

SSR11: The IST shall submit emergency command requests to the ICC. Reference 16, p. 5-17.

SSR12: The IST shall provide the ICC with updates to monitoring algorithms. Reference 10, p-7.

Table 1

MIDACS Internal Interfaces
Qualitative Data Transfer Characteristics

ORIGINATOR \ RECIPIENT	IST	ICC	TMCF	CDHF	DADS
IST		Moderate Occasional Real-Time Local/Remote	Low Occasional Routine Local/Remote		
ICC	Moderate Regular Real-Time Local/Remote			Low Occasional Real-Time Local	
TMCF	Low Occasional Routine Local/Remote			Low Occasional Routine Local/Remote	Moderate Occasional Routine Local/Remote
CDHF		High Regular Real-Time Local	Moderate Occasional Near-Real/Routine Local/Remote		High Regular Near-Real/Routine Local
DADS			Moderate Occasional Routine Local/Remote	High Occasional Routine Local	

KEY:

Transfer Rate
Frequency of Use
Timeliness Requirement
Path Length

SSR13: The ICC shall send to the DADS a history of commands and command loads. Reference 3, p. 5-17 and Reference 8, p. 5-12.

SSR14: The DADS shall receive data from the ICC pertaining to command load histories. **SOURCE:** Reference 3, p 5-17.

5.2.2 ICC - CDHF Interface

SSR15: The ICC will receive data quality assessments of science data from the CDHF. **SOURCE:** Reference ?

SSR16: The ICC will provide the CDHF with discipline data timelines of planned observation schedules. **SOURCE:** Reference ?

5.2.3 IST - TMCF Interface

(TBD)

5.2.4 DADS - TMCF Interface

SSR17: The DADS shall receive data products and ancillary data from the TMCF. **SOURCE:** Reference 3, p. 2-23.

SSR18: The DADS shall receive algorithms and calibration parameters for archive from the TMCF. **SOURCE:** Reference 3

5.2.5 TMCF - CDHF Interface

(TBD)

5.2.6 DADS - CDHF Interface

SSR19: The DADS shall receive processed data and ancillary data from the CDHF. **SOURCE:** Reference 3.

SSR20: The DADS shall receive browse data from the CDHF. **SOURCE:** Reference 3.

SSR21: The DADS shall receive calibration data from the CDHF. **SOURCE:** Reference 3

SSR22: The DADS shall send post-archive data to the CDHF for reprocessing. **SOURCE:** Reference 3

5.2.7 CDHF - DADS Interface

(TBD)

5.3 EXTERNAL INTERFACES

Tables 2 and 3 list the qualitative characteristics for each external interface within the MIDACS. Table 2 includes links originating within the MIDACS and terminating outside of the MIDACS. Table 3 includes links originating outside of the MIDACS and terminating within the MIDACS.

Table 2

MIDACS External Interfaces
Qualitative Data Transfer Characteristics

RECIPIENT \ ORIGINATOR	IST	ICC	TMCF	CDHF	DADS
IMC	Low Occasional Routine Local/Remote	Low Occasional Routine Local	Low Occasional Routine Local/Remote	Low Occasional Routine Local	Moderate Regular Routine Local
EMOC		Moderate Occasional Real-Time Local			
DHC		Low Occasional Real-Time Local		Low Occasional Real-Time Local	
Non-EOS			Low Occasional Routine Local/Remote		
Other EOS					High Occasional Routine Local/Remote
Perm. Archive					High Occasional Routine Local/Remote
Users	Low Occasional Routine Local/Remote				Moderate Occasional Routine Local/Remote

KEY:

Transfer Rate
Frequency of Use
Timeliness Requirement
Path Length

Table 3

MIDACS External Interfaces
Qualitative Data Transfer Characteristics

ORIGINATOR \ RECIPIENT	IST	ICC	TMCF	CDHF	DADS
IMC	Low Occasional Routine Local/Remote	Low Occasional Routine Local	Low Occasional Routine Local/Remote	Low Occasional Routine Local	Low Occasional Routine Local
EMOC		Low Occasional Routine Local			
DHC		High Regular Real-Time Local		High Regular Near-Real/Routine Local	
Non-EOS			Moderate Occasional Routine Local/Remote		Moderate Occasional Routine Local/Remote
Other EOS					High Occasional Routine Local/Remote
Perm. Archive					High Occasional Routine Local/Remote
Users	Low Occasional Routine Local/Remote				

KEY:

Transfer Rate Frequency of Use Timeliness Requirement Path Length

5.3.1 EMOC to ICC interface requirements

SSR23: The ICC snall provide instrument operations planning inputs to EMOC. (Reference 3, p. 2-21).

SSR24: The EMOC shall provide a consolidated plan for MODIS operations to the ICC. (Reference 3, p. 5-21).

SSR25: The ICC shall provide a detailed schedule for the MODIS operations to EMOC. (Reference 3, p. 2-18).

SSR26: The EMOC shall provide a conflict-free schedule developed by the PSC to the ICC (Reference 3, p. 5-23).

SSR27: The ICC shall transmit instrument commands to EMOC. (Reference 3, p. 2-18).

SSR28: The exchange of data and information between the MIDACS ICC and EMOC shall be through the NASA communication networks. (Reference 3, p. 5-28).

SSR29: The ICC shall transfer selected portions of instrument engineering data to EMOC to support its monitoring role. (Reference 3, p. 5-33).

SSR30: The ICC shall provide instrument status information to EMOC (Reference 3, p. 5-15).

SSR31: A detailed schedule shall be iterated between the EMOC and the ICC until approved. Reference 12.

SSR32: The EMOC and ICC shall maintain informational interfaces for relay of messages and management information. Reference 12.

SSR33: The ICC shall send emergency command loads to the EMOC. Reference 3, p 5-26

SSR34: The EMOC shall allocate current resource envelopes to the ICC. These envelopes may include power, thermal, tape recorder, and LAN usage, as well as, guidelines for scheduling. Reference 3, p 5-21,23

SSR35: The EMOC shall send the ICC status data. Reference 10, p-6

SSR36: The EMOC shall provide the ICC with the platform status data. Reference 12.

5.3.2 DHC to ICC Interface Requirements

SSR37: The DHC shall provide the ICC with Level-0 processed platform engineering data and Level-0 processed payload engineering data. (Reference 3, p. 5-33)

SSR38: The DHC shall provide the ICC with real-time engineering data in real time. (Reference 3, p. 5-33)

SSR39: The DHC shall provide the consolidated and checked ancillary data packets to the ICC. (Reference 3, p. 5-31)

5.3.3 DHC to CDHF Interface Requirements

SSR40: The exchange of data and information shall be effected through the NASA communication networks. (Reference 3, p. 5-33)

SSR41: The DHC shall transmit Level-0 science data to the CDHF. (Reference 3, p. 5-33).

SSR42: The DHC shall transmit the consolidated and checked ancillary data packets to the CDHF. (Reference 3, p. 5-31)

5.3.4 IMC to MIDACS Interface Requirements

SSR43: The MIDACS shall provide, in a timely fashion to the IMC, all the information on the data products generated by the MIDACS which include standard data products from CDHF, specialized products from TMCF, calibration products, algorithms used for generating data products, processing status, and necessary documentation. The DADS shall use already existing internal interfaces to collect from these facilities all the information needed by the IMC or users. SOURCE: Reference 3, p. 2-23,25.

5.3.5 Permanent Archives to DADS Interface Requirements

SSR44: The DADS shall transfer all the products in its archive to permanent archives (which need to be identified) after TBD years of active archival. (Reference 3, p. 3-12)

5.3.6 Other DADS to MIDACS Interface Requirements

SSR45: MIDACS functional elements shall be able to receive ancillary and/or correlative data from other EosDIS/DADS (which need to be identified) through first interrogating the IMC to locate data sources and availability. DADS may assume the role of contacting IMC and receiving data from other DADS and then relaying them to other MIDACS elements. SOURCE: Reference 5, Req. 7,30.

5.3.7 Non-Eos Data Sources to MIDACS Interface Requirements

SSR46: MIDACS functional elements shall be able to receive ancillary and/or correlativ data from other EosDIS/DADS (which need to be identified) through first interrogating the IMC to locate data sources and availability. The DADS may assume the role of contacting IMC and receiving data from other DADS and then relaying them to other MIDACS elements. SOURCE: Reference 5, Req. 7,30.

5.3.8 User to MIDACS Interface Requirements

SSR47: The DADS shall deliver requested data products, documentation, algorithms, and/or data processing status to the users electronically or via off-line storage media. SOURCE: Reference 3, p. 5-40,43.

SSR48: Users wishing to have particular configuration of the MODIS instrument shall contact the MODIS instrument team leader for scheduling of the instrument operations. SOURCE: Reference TBD.

6. PHYSICAL REQUIREMENTS

(TBD)

7. DELIVERY AND INSTALLATION REQUIREMENTS

(TBD)

8. DESIGN AND IMPLEMENTATION REQUIREMENTS

DSR1: The first architectural principle to be applied throughout the design of the EosDIS is layering. Layering breaks the diverse and complex system into easily comprehensible modules with clear "strata" in which common data handling functions reside. **SOURCE:** Reference 6, page 16.

DSR2: The second architectural design principle is standardization of formats and protocols through which data are exchanged between distributed elements of the system. **SOURCE:** Reference 6, page 16.

DSR3: Computer hardware should change when necessary to keep overhead low and to improve system capability. Software and procedural changes triggered by such hardware changes should be planned; benchmark tests and standard data sets for reprocessing should be defined to verify the operation of the whole system after such changes occur. **SOURCE:** Reference 6, page 25.

DSR4: The data processing architecture shall have a high degree of modularity and structure in order to have the adaptive flexibility required for the evolving character of data processing requirements. **SOURCE:** Reference 3.

DSR5: The ICC shall be designed for change; accommodating new hardware and software due to new instruments. Changes shall be controlled and documented. Change procedures shall be clearly defined. **SOURCE:** Reference 2 (ICC Facility).

DSR6: The MODIS ICC shall be colocated with the EMOC. **SOURCE:** Reference 2 (ICC Facility).

DSR7: The DADS requirements for ground storage functions can be met with commercial disk and tape drives ensuring conservative technological improvements. **SOURCE:** Reference 3 p. 6-18.

DSR8: The architectural approach of the CDHF shall be multi-tiered, using a layered network to meet the need for a limited number of widely used standard products and simultaneously distribute low level data to local or regional processing centers for generation of research or specialized products. **SOURCE:** Reference 6, p.30.

DSR9: Processing capacity and performance shall be capable of flexible enhancement to meet evolving needs defined by instrument teams. **SOURCE:** Reference 6, page vii.

DSR10: The DADS design and location shall be such as to provide for a smooth transition of archiving responsibility from the MIDACS to the permanent archive facility. **SOURCE:** Reference 3, p. 2-23.

DSR11: The DADS shall either be colocated with an existing permanent archive facility or electronically tied to such a facility. **SOURCE:** Reference 3, p. 5-35.

DSR12: The MIDACS design must provide proper access security of data. **SOURCE:** Reference 6, p. 28, and p.46.

DSR13: The DADS shall size base system for a user community of 1,000 to 10,000; 50 to 200 active at any time, ordering 5 to 10 tapes per month; 1 to 10 users ordering large volumes of data and handle up to 100 simultaneous users. **SOURCE**: Reference 5 (Req. No. 0324).

DSR14: Interactive scheduling tools for command sequence design and integration shall be developed for the ICC.

DSR15: The ICC shall be a dynamic system, capable of accommodating the growth and evolution of spacecraft instrumentation, technology, and user requirements. **SOURCE**: Reference 2 (ICC Facility).

DSR16: The ICC shall meet the following reliability, maintainability, and availability requirements: TBD. **SOURCE**: Reference 2 (ICC Facility).

9. DEVELOPMENT PLAN

9.1 OVERALL APPROACH TO DEVELOPMENT AND IMPLEMENTATION

(TBD)

9.1.1 Delivery

(TBD)

9.1.2 Installation

(TBD)

9.1.3 Acceptance Testing

(TBD)

9.2 DOCUMENTATION

(TBD)

9.3 TIME FRAMES AND MILESTONES

(TBD)

9.4 PARTICIPATION BY OTHER ORGANIZATIONS

(TBD)

APPENDIX A
LIST OF ACRONYMS

bps	bits per second
CCSDS	Consultative Committee for Space Data Systems
CDA	Command and Data Acquisition
CDHF	Central Data Handling Facility
CDOS	Customer Data and Operations System
CST	Calibration Support Team
DADS	Data Archive and Distribution System
DDC	Discipline Data Center
DHC	Data Handling Center
DIF	Data Interface Facility
DLR	Delivery and Installation Requirement
DSR	Design and Implementation Requirement
EMOC	EOS Mission Operations Center
EOS	Earth Observing System
EosDIS	EOS Data and Information System
FNR	Functional Requiremen
GSFC	Goddard Space Flight Center
IMC	Information Management Center
ICC	Instrument Control Center
IST	Instrument Support Terminal
Mbps	Megabits per second
MIDACS	MODIS Information, Data, and Control System
MODIS	Moderate Resolution Imaging Spectrometer
MODIS-N	MODIS nadir
MODIS-T	MODIS tiltable
NASA	National Aeronautics and Space Administration
NCDS	NASA Climate Data System
NODS	NASA Ocean Data System
NLDS	NASA Land Data System
NPOP-1	NASA Polar Orbiting Platform-1
NSSDC	National Space Science Data Center
PHR	Physical Requirement
PRR	Performance Requirement

PSC	Platform Support Center
SDMU	Science Data Management Unit
SOH	State-of-Health
SSIS	Space Station Information System
SRR	System Requirement
TBD	To Be Determined
TDRSS	Tracking and Data Relay Satellite System
TGT	TDRSS Ground Terminal
TMCF	Team Member Computing Facility

APPENDIX B
LIST OF ASSUMPTIONS

(TO BE SUPPLIED)

APPENDIX C

MODIS DATA SYSTEM DICTIONARY

Accepted-Data	=	*DADS ingested data that has been quality checked.*
Algorithm-Release-Announcement	=	*Announcement to the team that a debugged, working processing algorithm is now in use, containing information such as version numbers, availability of user's guide, etc.*
Analysis-Results	=	*Results of analysis of instrument performance over a long period which reflects trends in performance.*
Ancillary-Data	=	*Data other than MODIS-Instrument-Data required to perform MODIS data processing (such as platform and other instrument data).*
Archive-Ancillary-Data	=	*Ancillary data retrieved from the MODIS DADS.*
Archive-Data-Products	=	*MIDACS products routinely archived for potential user access and distributed in response to a product request.*
Archive-Data-Products-Release-Authorization	=	*Authorization to release data products in the DADS to data users.*
Archive-Data-Request	=	*A request for data to be retrieved from any EosDIS DADS.*
Authorized-Schedule-Data	=	*A schedule containing instrument resources and timelines, that have been approved by the EMOC through iteration with the ICC.*
Automated-Command-Sequences	=	*A human readable sequence of commands generated by the planning and scheduling processes and used for the generation of command loads.*
Browse-Data	=	*Subsets of a data set other than the directory and metadata that facilitates user selection of specific data having the required characteristics. For example, image data of a single channel with degraded resolution.*
Candidate-Observation-Sequence	=	*A human readable form of the instrument resources and timelines necessary to perform the observation request. These data are sent to the EMOC for approval.*
Catalog/Directory-Data	=	*A description of data available from the MIDACS DADS listed by platform, instrument, data processing level, algorithm identifier, parameter, time, geographic location, or combination.*

CDHF-Accepted-Data	=	Data from the DHC that has undergone TBD data validation checks.
CDHF-Database-Inquiry	=	*Request for CDHF temporary storage catalog information.*
CDHF-Database-Report	=	Response to CDHF database inquiry.
CDHF-Data-Products	=	Levels 1-4 MODIS data products.
CDHF-Ingested-Data	=	*Data received from the DHC that has been blocked by TBD methods.*
CDHF-Stored-Data	=	*Any subset of data sets cataloged and stored in the CDHF temporary storage.*
Command-Loads	=	*Encoded MODIS instrument command sequences as required by the on-board MODIS instrument control system and constructed so as to affect a specific action; e.g., "HV PWR ON".*
Command-Request	=	*A command load generated by the IST, verified by the ICC, and immediately transmitted to the EMOC.*
Coordinated-Observation-Plan	=	*Any data received by the IST which has been selected as an observation request which has been coordinated to determine its consistency with the EOS science objectives.*
Correlative-Data	=	*Scientific data not from the MODIS instrument used to verify, interpret, or validate MODIS data products.*
Correlative-Data-Request	=	*Information required to initiate and support the transfer of Correlative-Data to the requestor.*
Critical-Command-Request	=	*A command request issued by the monitoring function when the state-of-health of the instrument or its performance is degraded.*
DADS-Status-Inquiry	=	*Request for a specific type of DADS-Status-Report.*
DADS-Status-Report	=	*Description of the DADS status, resources utilization, and performance.*
Data-Products-Release-Announcement	=	*Announcement to the team that a validated specialized or correlative data product is available to the scientific community.*
DHC-Data-Request	=	*Request to redesignate packet handling and processing priorities.*

Displays	=	* Plots, images, a list of requested data or status of the instrument or ground system communicated visually.*
Distribution-Request	=	Request to send stored data, for production of MODIS data products, for archiving at the DADS or for use by the TMCF.
DQA-Criteria	=	*Factors used to assess data quality.*
DQA-Reports	=	*Results of routine data quality assessment associated with data receipt and data product operations.*
Engineering-Data	=	MODIS-Engineering-Data + Platform-Engineering-Data.
Formatted-Observation-Request	=	*Any observation request received by the ICC that has been proce sed for input into the generation of instrument timelines.*
Generic-Observation-Request	=	*Observation requests that are predetermined and are consistent with the original science plan.*
Geography-Data	=	*Data that can be used to identify land and ocean boundaries or other Earth features necessary for the implementation or generation of the instrument commands. Used in generating instrument timelines.*
Headers	=	*Inf ormation about the attributes of standard, non-standard, or data products.*
ICC-Data-Request	=	*A request for information from the ICC.*
IMC-Inquiry	=	*Request for ir formation on the operational status of the MODIS instrument or the MIDACS data system.* Production-Status-Inquiries + DADS-Status-Inquiries + Observation-Plan-Inquiry + Instrument Operational-Status-Inquiries
IMC-Inquiry-Response	=	Production-Reports + DADS-Status-Reports + Instrument-Status-Reports + Observation Plan-Information

Ingested-Data	=	*All products and data received by the DADS.* MODIS-Data-Products + Specialized-Products + Permanent-Archived-Data + Correlative-Data + Ancillary-Data + Processing-Algorithms
Instrument-Operational-Status-Inquiry	=	*An inquiry made by the IMC to determine the status of the ICC and/or the MODIS instrument.*
Instrument-Operations-Models	=	*Computer-compatible mathematical analogs of the MODIS instrument, used to estimate resource requirements during a modeled operation.*
Instrument-Status-Reports	=	*Information on the operating configuration of the MODIS instrument.*
IST-Coordination	=	*Planning and performance information relating to the MODIS instrument.*
Level-0-Data	=	*MODIS-Instrument-Data at original resolution, time order restored, with duplicates removed.*
Level-1A-Data	=	*Level 0 data which are reformatted reversibly, with Earth location, solar and instrument zenith angle, calibration data, and other ancillary data appended.*
Level-1B-Data	=	*Level-1A data to which the radiometric calibration algorithms have been applied, perhaps irreversibly, to produce radiances or irradiances, and to which the Earth-location and zenith-angle algorithms have been applied at the grid points.*
Level-2-Data	=	Geophysical parameter data derived from the Level-1B data by application of geophysical parameter algorithms.
Level-3-Data	=	Earth-gridded geophysical parameter data (including Level-1 radiances), which have been averaged or composited in time and space.
Level-4-Data	=	TBD analyses of the lower levels of MODIS data.
Management-Information	=	*Internal information about the DADS data store and catalog.*
Mission-Planning-Information	=	*Instrument operations schedule; information provided by the ICC to the CDHF to verify receipt and specify complete handling of data sets.*
MODIS-Data-Products	=	Levels 1-4 Data Products + Browse Data

MODIS-Engineering-Data	=	*Data other than MODIS-Science-Data generated within the MODIS instrument.*
MODIS-Instrument-Data	=	*Data originating within the MODIS instrument.*
	=	MODIS-Science-Data + MODIS-Engineering-Data
MODIS-Science-Data	=	*Unprocessed observations as generated by the MODIS instrument.*
Monitoring-Algorithms	=	*A procedure for transforming information for processing and displaying MODIS science and engineering data for monitoring instrument performance.
Monitoring-Database-Inquiry	=	*Inquiry of the monitoring database to determine what instrument monitoring reports, data, and analyses are currently available.*
Monitoring-Database-Report	=	*Report of instrument monitoring functions and availability.*
Near-Real-Time-Data	=	*MODIS-Instrument-Data designated for Priority Processing.*
Near-Real-Time-Processing	=	*Processing accomplished within three to eight hours after input data become available.*
Near-Real-Time-Request	=	*Request to handle data in Priority Mode.*
Non-Standard-Products	=	*Products not routinely produced, standard products produced by an alternate algorithm, or combinations of standard products.*
Observation-Plan-Coordination	=	*Information exchange between a user requesting special MODIS services and the MODIS Instrument Team Leader. The exchange should culminate in a plan for MODIS Instrument Operation.*
Observation-Plan-Information	=	*Information describing observations planned for the MODIS instrument.*
Observation-Plan-Inquiry	=	*A request for information on planned MODIS instrument observations.*
Observation-Planning-Data	=	*Any data received by the IST which has been selected as a possible observation request which will undergo coordination to determine its consistency with the EOS science objectives.*

Observation-Request	=	*MODIS measurement request not covered by the current schedule or data handling procedures. The request is consistent with general science objectives and science mission plans and goals.*
Observation-Resource-Requirements	=	*Predicted instrument resources necessary to fulfill the objectives of the observation request.*
Orbit-&-Attitude-Data	=	*Data that describes the current or predicted orbital position and pointing of the platform or instrument axes.*
Order-Found-Status	=	*Status of the product order when located and retrieved. This information can be sent to the user via the IMC.*
Order-Placed-Status	=	*Status of the Product Order when the user request has been processed. This information can be sent to the user via the IMC.*
Order-Status-Data	=	*Status and billing of the product ordered through IMC.* Order-Found-Status + Order-Placed-Status
Organized-Data	=	*Data products which have been grouped according to the header, e.g., Level 1A data, Land data, or Ocean data.*
Permanent-Archive-Data	=	*Data retrieved from permanent archival storage.*
Permanent-Archive-Data-Request	=	*Request for data from the permanent archive.*
Planning-Input	=	*Information supplied to the Team Leader by the Team Members used to developed the Science Management Plan.*
Platform-Engineering-Data	=	*Data produced by the platform sensors that are used for operating the platform or as ancillary data.*
Preliminary-Algorithms	=	*Recently developed algorithms which have not been fully tested.*
Preliminary-Specialized-Data-Products	=	*Specialized data products which have not yet been verified or validated.*
Priority-Processing	=	*Immediate processing of designated data items without considering data item position in processing queues (cf. Routine Processing). Includes both Real-Time-Processing and Near-Real-Time-Processing.*

Priority-Ranked-Requests	=	*Received requests which the Team Leader has given priority ranking in concordance with the Science Management Plan. The Team Leader provides the schedule to the Team Members.*
Processed-Data	=	*Results of analyzing engineering data in real-time or trend analysis functions.*
Processed-User-Request	=	*Data request that has been processed by the Receive-User-Request function and is used to locate and retrieve the data.*
Processing Algorithms	=	*A mathematical procedure used by the CDHF or the TMCF to process the MODIS data.
Processing-Instructions	=	*Procedure and scheduling instructions that command the processing steps and the type of processing (routine, near-real-time, special, or reprocessing).*
Production-Report	=	Production Schedule + Production Status
Production-Status-Inquiry	=	*Request for a production report.*
Quick-Look-Science-Data	=	*A subset (up to 100%) of MODIS-Science-Data (Real-Time or Priority Playback) used to monitor MODIS instrument performance (may not be completely processed).*
Real-Time-Processing	=	*Processing accomplished essentially as input data becomes available with only minimal storage delays for data buffering.*
Received-CDHF-Data	=	Data received by the CDHF (received DHC data, archive data products, processing algorithms, DQA criteria).*
Received-Data	=	*Cataloged data stored at the TMCF's used for algorithm development and validation/verification of data.*
Received-DHC-Data	=	Level-0 data and ancillary data from the DHC that has been acceptance checked and reformatted and has had a header appended.
Received-Requests	=	*A TM data products request, TM observation request, or TM data processing request received by the Team Leader from Team Members in TMCF.*
Reference-Monitoring-Profile	=	*Expected MODIS instrument engineering parameter levels annotated with limits at which alarm status should be declared.*

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Requested-Data-Products	=	Data retrieved by the Process User Request function for distribution on a physical medium.*
Requested-Direct-Data	=	*Products generated on physical medium for distribution.*
Resource-Envelope	=	*Maximum allowable resource consumption levels for the MODIS instrument.*
Retransmission-Request	=	*Request for retransmission of data packets that do not meet quality standards.*
Retrieved-Data	=	*Data retrieved from DADS storage by the Process-User-Request function to fill a product order.*
Revised-Algorithms	=	*Algorithms which are tested and are ready for implementation.*
Routine-Processing	=	*Processing that considers data item position in data processing queues. Cf. Priority Processing.*
Schedule-Data	=	*English language descriptions of planned platform maneuvers or instrument operations.*
Science-Management-Plan	=	*A plan which states the areas of responsibility, technical goals, and time tables of each Team Member, developed by the Team Leader and Team Members.*
Selected-Data-Products	=	*Subsets of standard, near-real-time or specialized data product.*
Selected-Science-Data	=	*A subset of MODIS-Science-Data or MODIS data products used to monitor MODIS instrument performance. These data are transmitted to the ICC by the CDHF to analyze past instrument performance and are not used for real-time monitoring.*
Selected-Science-Data-Request	=	*A request for selected science data for monitoring instrument performance.*
Specialized-Data-Products	=	*Data products which are considered part of a specific research investigation and are produced for a limited region or time period, or data products which are not accepted by the project as standard items.*
Status-&-Trending-Data	=	*Instrument engineering and/or science data that has been analyzed to determine the operating status of the instrument and long-term trends. These data will be used to update any instrument models or algorithms used in analyzing engineering data.*

Stored-Data-Request	=	Request for stored data from the CDHF temporary storage.
Stored-Processed-Data	=	*Data which has been processed in real-time and stored for analyzing long-term trends in performance.*
TMCF-Obse. vation-Request	=	*A TM-Observation-Request after approval by the Team Leader.*
TMCF-Processing-Request	=	Standard-Processing-Requests + Reprocessing Requests (approved by Team Leader) + Specialized-Data-Processing-Request
TMCF-Request-Response	=	*Response of the Team Leader to a TMCF-Processing-Request.*
TM-Data-Processing-Request	=	*Team Member data processing request not yet approved by the Team Leader for general release.*
TM-Data-Products-Request	=	*Team Member data products request not yet approved by the Team Leader for general release.*
TM-Observation-Request	=	*Team Member observation request not yet approved by the Team Leader.*
User-Data-Parameters	=	*Parameters used to locate and retrieve data to respond to a data request. Parameters used to identify data type, location, etc. in order to access the data.*
User-Observation-Request	=	*A special observation request not included in the current schedule but consistent with general science objectives and the science mission plan.*
User-Processing-Request	=	*Request by a User to generate MODIS-Data-Products not previously available.*
User-Product-Request	=	*Requests that distributed data products be delivered to a User from the MIDACS DADS.*
User-Request	=	User Product Request + User Observation Request + User Processing Request.
User-Request-Response	=	*Response to a user's request.*
Valid-Observation-Sequence	=	*A time-ordered sequence of instrument operations reflecting observation requests which have been determined to be consistent with the science plan, feasible from an orbit/geometry point-of-view and possibly coordinated with specific scenes.*

Verification/Validation-Study-Results = *Results of correlative and modeling studies.*

APPENDIX D

MODIS DATA RATE AND VOLUME

MODIS_INSTRUMENT

OPERATION

	MODIS-N		MODIS-T	
	DAY	NIGHT	DAY	NIGHT
Number of Channels	40	15	64	0
% of Operation	100	100	100	-

STORED_COMMAND_REQUIREMENT

	MODIS-N	MODIS-T
No. of Mode change/day	28	28
No. of Comd/Mode Change	2	2
No. of Tilt Comd/day	-	644
No. of Bytes/Comd.	64	64
Total Bytes/day	3,584	44,800
Total Bytes/week	25,088	313,600

DATA_RATES

(Numbers in Mbps)

	MODIS-N		MODIS-T		TOTAL
	DAY	NIGHT	DAY	NIGHT	
Instrument Data	9.65	1.54	6.56	0	
Calibration Info	0.45	0.08	0.15	0	
Engineering Info	0.01	0.00	0.01	0	
Total	10.11	1.62	6.72		
40 % Oversampling	3.86	0.62	2.63		
Total	13.97	2.24	9.35		
Average (No Oversampling)	5.87		3.36		9.23
Average (Oversampling)	8.11		4.68		12.79

Data Volume/Day

Maximum : 140 Giga Bytes
Minimum : 100 Giga Bytes

MODIS data requires Grade II TDRSS service

APPENDIX E

A FIRST-CUT AT MODIS DATA STORAGE AND PROCESSING REQUIREMENTS

1. MODIS data rate: 9.23 Megabits/second (assume no oversampling)

2.

Data Level	Path Length[1]	Data Factor[1]	Data Volume
Level-0	3	1.1 x Raw	0.88 Terabits/day
Level-1A	8	1.1 x Level-0	0.96 Terabits/day
Level-1B	12	1.0 x Level-1A	0.96 Terabits/day
Level-2	20	2.0 x Level-1B	1.93 Terabits/day
Level-3	30	.15 x Level-2	0.29 Terabits/day

[1]From EosDIS Baseline Report May 26 Draft.

3. 24 hours of data will be processed within 8 hours.
4. Reprocessing will occur at twice the normal processing rate.
5. Processor utilization will not exceed 70%.
6. Maintenance, near-real-time, browse, developmental, and other activities may add 40% of additional processing requirements.
7. Constraints 3-6 require a contingency factor of 6 in processing capacity.
8.

Data Level	Basic Processing Capacity	Contingency Processing Capacity
Level-1A	89 MIPS	536 MIPS
Level-1B	134 MIPS	804 MIPS
Level-2	447 MIPS	2,680 MIPS
Level-3	100 MIPS	603 MIPS
Total	770 MIPS	4,624 MIPS

9. Store 1 week of data for processing on line.
10. Store 2 weeks of data for reprocessing on line.
11. Store 2 years of data off line (except for Level-0).
12. Store 1/2 year of data off line for reprocessing.
13.

Data Level	On-Line Storage Capacity	Off-Line Storage Capacity
Level-0	2.3 TBytes	
Level-1A	2.5 TBytes	110 TBytes
Level-1B	2.5 TBytes	110 TBytes
Level-2	5.1 TBytes	220 TBytes
Level-3	0.8 TBytes	33 TBytes
Total	13.2 TBytes	473 TBytes

14. As we consider the MODIS data system architecture and system specifications, our task is to refine the rough estimates of path length, data volume ("factors"), and the amount of contingency allowance. The numbers outlined above provide a first very rough cut at the processing and storage requirements for the MODIS data system, which will be updated as we learn more about the processing algorithms to be applied to the MODIS data.

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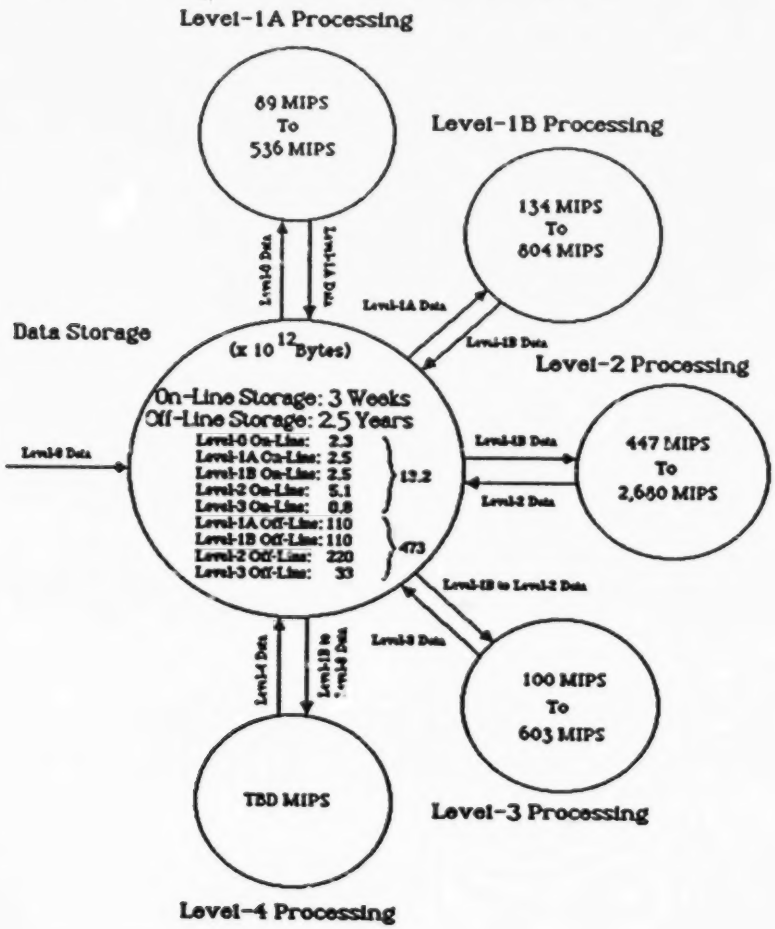
A "First Cut" at MODIS Data Storage and Processing Requirements



MODIS-N Data Storage Requirements

Mean Raw Data Rate (per second)
Bits: 5.87E+06 Bytes: 7.34E+05

Daily Level-0 Data Volume (110% of Raw)
Bits: 5.58E+11 Bytes: 6.97E+10

Daily Level-1A Data Volume (110% of Level-0)
Bits: 6.14E+11 Bytes: 7.67E+10

Daily Level-1B Data Volume (100% of Level-1A)
Bits: 6.14E+11 Bytes: 7.67E+10

Daily Level-2 Data Volume (200% of Level-1B)
Bits: 1.23E+12 Bytes: 1.53E+11

Daily Level-3 Data Volume (15% of Level-2)
Bits: 1.84E+11 Bytes: 2.30E+10

Minimum Daily Level-4 Data Volume (50% of Level-3)
Bits: 9.21E+10 Bytes: 1.15E+10

Maximum Daily Level-4 Data Volume (1000% of Level-3)
Bits: 1.84E+12 Bytes: 2.30E+11

Minimum Daily Data Volume (Level-0 to Level-4)
Bits: 3.29E+12 Bytes: 4.11E+11

Maximum Daily Data Volume (Level-0 to Level-4)
Bits: 5.04E+12 Bytes: 6.30E+11

Minimum Weekly Data Volume (Level-0 to Level-4)
Bits: 2.30E+13 Bytes: 2.88E+12

Maximum Weekly Data Volume (Level-0 to Level-4)
Bits: 3.53E+13 Bytes: 4.41E+12

Minimum Annual Data Volume (Level-0 to Level-4)
Bits: 1.20E+15 Bytes: 1.50E+14

Maximum Annual Data Volume (Level-0 to Level-4)
Bits: 1.83E+15 Bytes: 2.29E+14

MODIS-T Data Storage Requirements

Mean Raw Data Rate (per second)
Bits: 3.36E+06 Bytes: 4.20E+05

Daily Level-0 Data Volume (110% of Raw)
Bits: 3.19E+11 Bytes: 3.99E+10

Daily Level-1A Data Volume (110% of Level-0)
Bits: 3.51E+11 Bytes: 4.39E+10

Daily Level-1B Data Volume (100% of Level-1A)
Bits: 3.51E+11 Bytes: 4.39E+10

Daily Level-2 Data Volume (200% of Level-1B)
Bits: 7.03E+11 Bytes: 8.78E+10

Daily Level-3 Data Volume (15% of Level-2)
Bits: 1.05E+11 Bytes: 1.32E+10

Minimum Daily Level-4 Data Volume (50% of Level-3)
Bits: 5.27E+10 Bytes: 6.59E+09

Maximum Daily Level-4 Data Volume (1000% of Level-3)
Bits: 1.05E+12 Bytes: 1.32E+11

Minimum Daily Data Volume (Level-0 to Level-4)
Bits: 1.88E+12 Bytes: 2.35E+11

Maximum Daily Data Volume (Level-0 to Level-4)
Bits: 2.88E+12 Bytes: 3.60E+11

Minimum Weekly Data Volume (Level-0 to Level-4)
Bits: 1.32E+13 Bytes: 1.65E+12

Maximum Weekly Data Volume (Level-0 to Level-4)
Bits: 2.02E+13 Bytes: 2.52E+12

Minimum Annual Data Volume (Level-0 to Level-4)
Bits: 6.85E+14 Bytes: 8.57E+13

Maximum Annual Data Volume (Level-0 to Level-4)
Bits: 1.05E+15 Bytes: 1.31E+14

MODIS Total Data Storage Requirements

Mean Raw Data Rate (per second)
Bits: 9.23E+06 Bytes: 1.15E+06

Daily Level-0 Data Volume (110% of Raw)
Bits: 8.77E+11 Bytes: 1.10E+11

Daily Level-1A Data Volume (110% of Level-0)
Bits: 9.65E+11 Bytes: 1.21E+11

Daily Level-1B Data Volume (100% of Level-1A)
Bits: 9.65E+11 Bytes: 1.21E+11

Daily Level-2 Data Volume (200% of Level-1B)
Bits: 1.93E+12 Bytes: 2.41E+11

Daily Level-3 Data Volume (15% of Level-2)
Bits: 2.89E+11 Bytes: 3.62E+10

Minimum Daily Level-4 Data Volume (50% of Level-3)
Bits: 1.45E+11 Bytes: 1.81E+10

Maximum Daily Level-4 Data Volume (1000% of Level-3)
Bits: 2.89E+12 Bytes: 3.62E+11

Minimum Daily Data Volume (Level-0 to Level-4)
Bits: 5.17E+12 Bytes: 6.46E+11

Maximum Daily Data Volume (Level-0 to Level-4)
Bits: 7.92E+12 Bytes: 9.90E+11

Minimum Weekly Data Volume (Level-0 to Level-4)
Bits: 3.62E+13 Bytes: 4.52E+12

Maximum Weekly Data Volume (Level-0 to Level-4)
Bits: 5.54E+13 Bytes: 6.93E+12

Minimum Annual Data Volume (Level-0 to Level-4)
Bits: 1.88E+15 Bytes: 2.35E+14

Maximum Annual Data Volume (Level-0 to Level-4)
Bits: 2.88E+15 Bytes: 3.60E+14

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Assume complete processing of 24 hours of data in 8 hours --> factor of 3
Assume reprocessing is performed at 2 X processing rate during remaining 16 hours
Assume processor utilization is 70%
Assume 40% additional resource requirements for browse, near-real-time, maintenance, and other operations
Resultant multiplicative factor is (24/8) * 1.4 / .7 = 6
MIPS necessary = Path length * Bit rate (Mbps) * Multiplicative factor; Bit rate = Daily data volume / 86,400

MODIS-N Data Processing Requirements

Level-1A Data Processing		
Path Len:	8 MIPS:	341
Level-1B Data Processing		
Path Len:	12 MIPS:	511
Level-2 Data Processing		
Path Len:	20 MIPS:	1,705
Level-3 Data Processing		
Path Len:	30 MIPS:	384
Level-1A to Level-3 Da		Processing
Path Len:	16 MIPS:	2,941

MODIS-T Data Processing Requirements

Level-1A Data Processing		
Path Len:	8 MIPS:	195
Level-1B Data Processing		
Path Len:	12 MIPS:	293
Level-2 Data Processing		
Path Len:	20 MIPS:	976
Level-3 Data Processing		
Path Len:	30 MIPS:	220
Level-1A to Level-3 Data Processing		
Path Len:	16 MIPS:	1,683

MODIS Total Data Processing Requirements

Level-1A Data Processing		
Path Len:	8 MIPS:	536
Level-1B Data Processing		
Path Len:	12 MIPS:	804
Level-2 Data Processing		
Path Len:	20 MIPS:	2,680
Level-3 Data Processing		
Path Len:	30 MIPS:	603
Level-1A to Level-3 Data Processing		
Path Len:	16 MIPS:	4,624

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16. Abstract

The MODIS Information, Data, and Control System (MIDACS) Level II Functional Requirements Document establishes the functional requirements for MIDACS and provides a basis for the mutual understanding between the users and the designers of the EosDIS, including the requirements, operating environment, external interfaces, and development plan. In defining the requirements and scope of the system, this document describes how MIDACS will operate as an element of the EOS within the EosDIS environment. This version of the Level-II Requirements Document follows an earlier release of a preliminary draft version. The sections on functional and performance requirements do not yet fully represent the requirements of the data system needed to achieve the scientific objectives of the MODIS instruments and science teams. Indeed, the team members have not yet been selected and the team has not yet been formed; however, it has been possible to identify many relevant requirements based on the present concept of EosDIS and through interviews and meetings with keys members of the scientific community. These requirements have been grouped by functional component of the data system, and by function within each component. These requirements have been merged with the complete set of Level-I and Level-II context diagrams, data flow diagrams, and data dictionary.

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Data Systems		

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